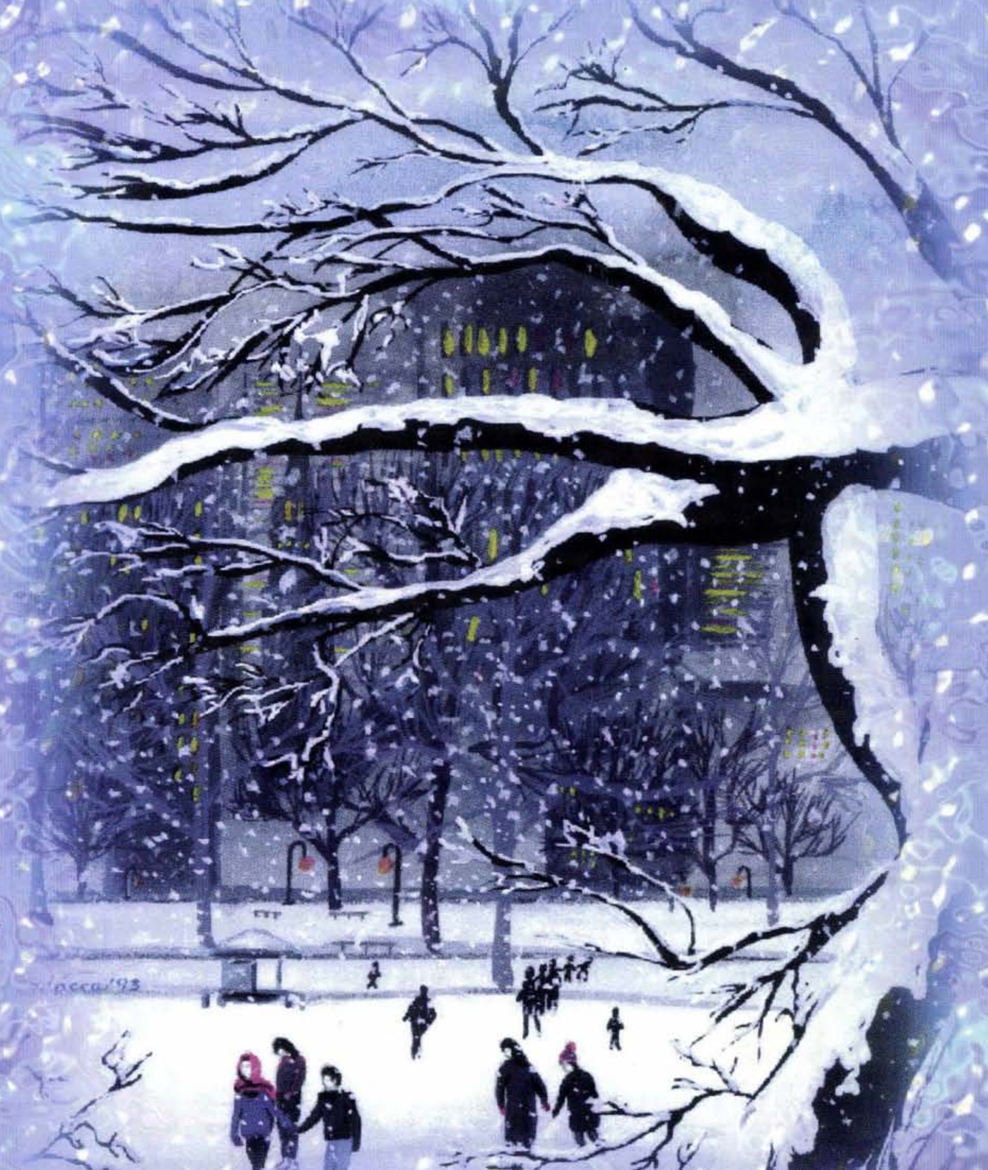
Nuts & Volts

Exploring Electronics And Technology For The Hobbyist And Professional

December 1998 Vol. 19 No. 12



Merry Christmas
from all of us at
Nuts & Volts

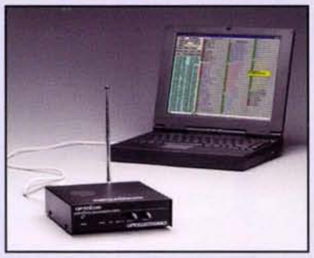
U.S. $3.50 CANADA $4.50

12>

0 74470 89295 3

Write in 214 on Reader Service Card.

New Product News



OPTOCOM PC-CONTROLLED COMMUNICATIONS RECEIVER

Optoelectronics, Inc. announces the all new Optocom PC-controlled communications receiver. The Optocom is the only PC-controlled communications receiver available today that has the ability to decode and follow both Motorola and LTR trunked systems on any frequency band, including 400 MHz, 500 MHz, 800 MHz, and 900 MHz. Another exclusive Optocom feature is the capability to follow both trunked systems and conventional frequencies simultaneously. In addition to Motorola and LTR decoding, the Optocom also decodes CTCSS, DCS, and DTMF.

The Optocom is a high-speed triple conversion receiver that is the fastest PC-controlled communications receiver available today, scanning at speeds up to 100 channels per second due to another Optocom exclusive feature, pipeline tuning.

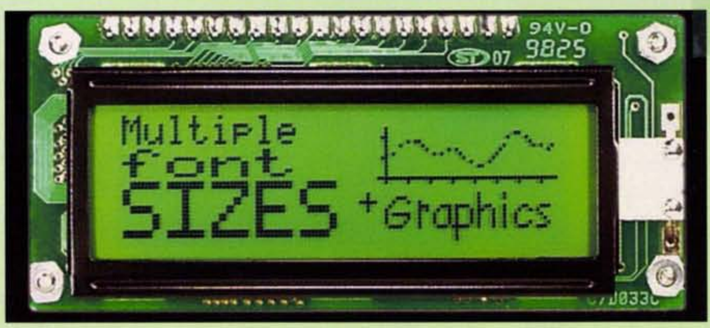
The Optocom also provides the exclusive store and scan feature, which allows the user to download up to 28 different frequencies or one talk group ID into the Optocom's internal memory for scanning away from the computer, an ideal way to track one talk group ID in mobile applications.

The Optocom also has a built-in data slicer circuit for decoding of popular FSK programs such as ACARS and WeFax, using third-party software.

Other Optocom features include a CI-5 port for reaction tuning by the popular Scout frequency recorder, squelch and volume controlled by both software and hardware, and dedicated decoder plug-in buss for future third-party applications.

For more information, contact:

OPTOELECTRONICS, INC.
5821 N.E. 14th AVE., DEPT. NV
FT. LAUDERDALE, FL 33334
954-771-2050 FAX: 954-771-2052
E-MAIL: sales@optoelectronics.com
WEB: www.optoelectronics.com



SGX-120L SERIAL GRAPHICS LCD

The SGX-120L is a graphics LCD with a serial interface. It accepts data over a 2400- or 9600-baud serial connection (e.g., RS-232) and displays text and graphics on a high-contrast 120x32 pixel screen.

Text formatting is straightforward, using standard control characters like carriage returns, tabs, backspace, etc. Additional instructions tap the display's more advanced capabilities, like multiple fonts and font sizes from 4 mm to 8 mm (0.16 to 0.32 in.), automatic right-alignment, backlight control, and reversed (light-on-dark) printing.

Graphics capabilities include plotting points, drawing lines, and displaying full-screen images. The font and up to six screen images are stored in onboard EEPROM. Users can create or edit fonts and up to six screen images in a PC paint program, then download them to the SGX-120L using free software included with the display.

The SGX-120L draws only 10 mA with the LED backlight off and 60 mA with it on. At 80x36 mm (3.15x1.42 in.), it is the same size as a two-line by 16-character text-only LCD.

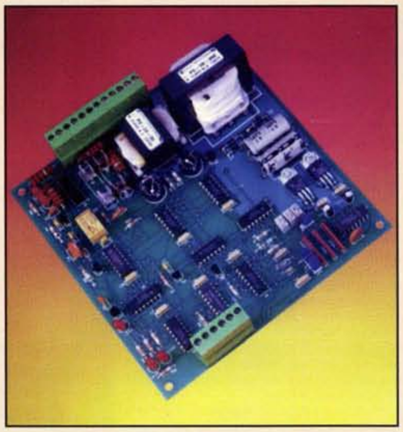
Pricing for SGX-120L (p.n. SGX-120L) ranges from $99.00 (quantity 1) to $69.00 (quantity 100+).

For more information, contact:

SCOTT EDWARDS ELECTRONICS, INC.
1939 S. FRONTAGE RD., STE. F DEPT. NV
SIERRA VISTA, AZ 85635
520-459-4802 FAX: 520-459-0623
WEB: www.seetron.com

Showcase your New Products here! Send all press releases or information/photos to:
Nuts & Volts Magazine
430 Princeland Court, Corona, CA 91719
or E-Mail to newproducts@nutsvolts.com

ELECTRONIC MOP



A new electronic motor operated potentiometer for OEM and retrofit applications which replaces existing MOPs with a solid-state device that allows multiple operation stations from one PC board is being introduced by Waddington Electronics, Inc.

Featuring a separate rate adjustment for increasing and decreasing output and one to increase, decrease, reset, jog, and sum inputs, it has adjustable gain and offset with automatic reset after power on.

Providing differential inverting or non-inverting summing input, selective bipolar (-10 to +10 VDC) or (0 to +10 VDC) output, and selective inverting and non-inverting output, the Waddington Electronic MOP has opto-isolated control input signals.

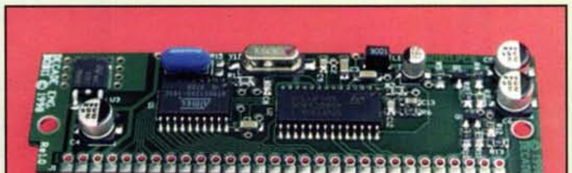
This versatile board permits the use of internal isolated 24 VDC or external 5 to 240 VAC or DC signals to control inputs.

The Waddington Electronic MOP is priced at $295.00 (list).

For more information, contact:

WADDINGTON ELECTRONICS, INC.
25 WEBB ST., DEPT. NV
CRANSTON, RI 02920
401-781-3904 FAX: 401-781-1650
E-MAIL: johnwn@ids.net

BOB II VIDEO TEXT DISPLAY MODULE



Decade Engineering announces BOB-II, their second-generation video text display module. BOB-II snaps into a common 30-pin SIMM socket and lets your PC or microcontroller display up to 11 lines of 28 characters – 308 total – in standard NTSC or PAL composite video systems. Basic character graphics and Euro language support are provided.

BOB-II generates matte background video on-board, or genlocks to your external video source and superimposes text over the image. Video mode switching is fully automatic. Character transparency and brightness are variable using external pots, if desired. You can draw attention to important messages with character blinking or background display options.

Programmed control of BOB-II is effected by simple commands and text sent as plain ASCII codes through a speedy (9600bps) serial data link. Direct control from the PC keyboard is possible with any standard ASCII terminal program, e.g., HyperTerminal.

BOB-II requires 65 mA from an unregulated 12 VDC source, and offers a regulated +5V output to power associated equipment.

BOB-II (NTSC) pricing is $79.95 for single units. The PAL version is slightly higher.

For more information, contact:

DECADE ENGINEERING
5504 VALVIEW DR. S.E., DEPT. NV
TURNER, OR 97392-9517
503-743-3194 FAX: 503-743-2095
E-MAIL: decade@worldnet.att.net
WEB: www.decadenet.com

Continued on page 91

Big sound from a stereo radio—without the big price!

Zenith Audio, a leading electronics manufacturer designs a "Small Footprint", "Big Sound" stereo system that's perfect for the home or office and priced below $100.

by John Jameson

I leaned back slowly in my chair with my eyes closed, listening to the haunting melody of a Mozart symphony. The acoustics were flawless, and the room was soon filled with full, rich stereo sound. From the crisp highs of the flutes to the tooth-rattling bass of the kettle drums, the music was crystal-clear and powerful. I could distinguish the distinct sounds from each individual musician, and as the orchestra reached the finale I almost fell out of my seat from the awesome force of the music. As the music faded, I leaned forward and hit a button on the stereo clock radio. I had a concert to go to that night—it was time to check the weather.

Ultimate sound machine. Zenith Audio has developed a Digital Stereo Clock Radio that boasts the acoustic quality and practical features of stereo radios four times as expensive. You'll be amazed at the sound quality and powerful bass you get from a radio this small and this affordable. This stereo radio features an 11-key handheld remote control and an input jack for CD players or other audio sources.

The best bass. Many small stereo radios can sound tiny and weak. This unit has an exclusive EXB button for expanded bass performance. It intensifies the lower tones for CD or FM stations, giving you rich, full and powerful stereo sound. If you want to listen to the stereo in private, there is a headphone jack on the side of the unit.

Compact Speakers with a Big Sound

The Zenith Audio Clock Radio has an exclusive EXB button for expanded bass performance. It intensifies the lower tones for CD or FM stations, giving you rich, full and powerful stereo sound.

Micro-Electronic Sound Breakthrough

State of the art stereo sound quality in a stylish cabinet

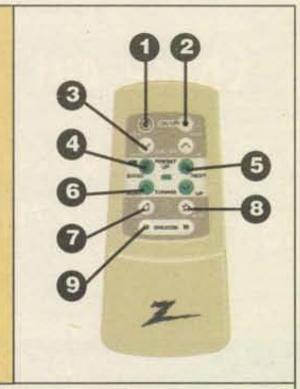
- AM/FM/TV Bands
- Stereo Speakers with Crystal Sound System
- Digital Weather Band
- 37 Preset Station Memories
- Ascending Tone Alarm
- Wake/Sleep to Radio, Weather or TV Band
- "Fail-safe" Alarm System

Loaded with features. You won't find a tabletop stereo with more added options. The AM/FM radio features digital tuning for pinpoint reception and crystal-clear sound. The STEREO indicator allows you to tune in to the stereo signal. It also picks up TV and WEATHER signals with 13 TV channels and 7 Weather channels, so your Zenith Audio Clock Radio is a great source of news, entertainment and information. You can program the unit's memory for 37 preset stations, and the tuning buttons can operate either manually or in a automatic search mode.

Practical functions. The backlit clock has several alarm functions, so you can wake to either radio, TV, weather or a buzzer. The sleep timer allows you to fall asleep to up to 90 minutes of music, TV or weather and then shuts off automatically. In the morning, if you need a few extra minutes of sleep, press the SNOOZE bar on the control panel or on the remote. The radio or alarm tone stops for 10 minutes and then sounds again. The process can be repeated several times as required. The unit's battery backup system will maintain the time, alarm and preset station memories in the event of a temporary power interruption. There is even a low battery indicator so you'll never oversleep in the event of a power failure.

Factory direct risk-free offer. You can spend hundreds of dollars more on a stereo radio, but why do it? We get the Stereo Clock Radio direct from Zenith Audio and pass the savings on to you. This product comes with a one-year manufacturer's limited warranty and Comtrad's exclusive risk-free home trial. If you are not satisfied for any reason, simply return it within 90 days for a full "No Questions Asked" refund.

1. Mute
2. Power
3. Volume
4. Band
5. Preset
6. Tuning
7. Alarm
8. Sleep
9. Snooze



11-key full function remote works up to 15 feet away.

The Zenith Crystal Clear Stereo comes in white or black.

Zenith Crystal Clear Stereo $99.95 $12 S&H

Please specify white or black.

Please mention promotional code **4244-14637**

For fastest service, call toll-free 24 hours a day

800-992-2966

DISCOVER NOVUS | VISA | MasterCard | American Express Cards

To order by mail, send check or money order for the total amount including S&H. To charge it to your credit card, enclose your account number and expiration date.

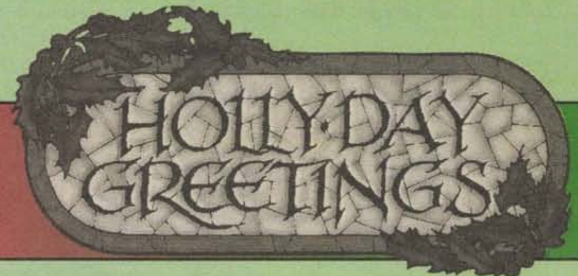
Virginia residents only—please include 4.5% sales tax.

comtrad industries

2820 Waterford Lake Dr., Suite 102
Midlothian, Virginia 23113

Volume 19 No. 12 • DECEMBER 1998

Contents



John Doggett wins with Nuts & Volts!

See page 54 for details!!

Check out Santa's Special on page 97!!

DEPARTMENTS

CLASSIFIED AD INDEX

Nuts & Volts Magazine is published monthly for $19.00 per year by T&L Publications, Inc., 430 Princeland Court, Corona, CA. POSTMASTER: Send address changes to Nuts & Volts Magazine, 430 Princeland Court, Corona, CA 91719.

ARTICLES

COLUMNS

Nuts & Volts Magazine encourages article submissions and queries. Send a SASE for a copy of our writer's guidelines.All submissions should be on 5-1/4 or 3-1/2 inch diskettes and include hard copy as well.If return of materials is requested, include a SASE with your submission.

Deadlines should be discussed in advance with the editor, but generally all material should be submitted two weeks prior to the 1st of the month for the next month's issue.

Published Monthly By
T & L Publications, Inc.
430 Princeland Court
Corona, CA 91719
(909) 371-8497
FAX (909) 371-3052

E-Mail
editor@nutsvolts.com
URL
http://www.nutsvolts.com

Subscription Order ONLY Line 1-800-783-4624

Publisher
Jack Lemieux *N6ZTD*

Editor
Larry Lemieux *KD6UWV*

Managing Editor
Robin Nelson *KD6UWS*

On-The-Road Exhibit Coordinator
Audrey Lemieux *N6VXW*

Subscriptions
Abby Madain

Classified Ads
Natalie Sigafus

All advertising is subject to publisher's approval. We are not responsible for mistakes, misprints or typographical errors. Nuts & Volts Magazine assumes no responsibility for the availability or condition of advertised items or for the honesty of the advertiser. The publisher makes no claims for the legality of any item advertised in Nuts & Volts. This is the sole responsibility of the advertiser. Advertisers and their agencies agree to indemnify and protect the publisher from any and all claims, action or expense arising from advertising placed in Nuts & Volts. Please send all subscription orders, correspondence, UPS, overnight mail and artwork to: 430 Princeland Court, Corona, CA 91719.

The closing date for each issue is the 5th of the prior month, e.g., the closing date for the June issue is May 5th. Ad copy to be typeset by Nuts & Volts should be received one week prior to the closing date. Call or write for current advertising rates.

CHANGE OF ADDRESS

If you are moving, notify us AS SOON AS POSSIBLE so we can continue your subscription without interruption.

Your magazine **WILL NOT** automatically be forwarded to you by the post office, so it's important to submit your change of address directly to Nuts & Volts. We will not be able to replace missed issues of the magazine due to unreported address changes.

When you send in your new address, include a current mailing label from the magazine with your account number on it. If you do not have a mailing label, be sure to include your old address and the name(s) under which the subscription was submitted.

DON'T MISS A SINGLE ISSUE!!

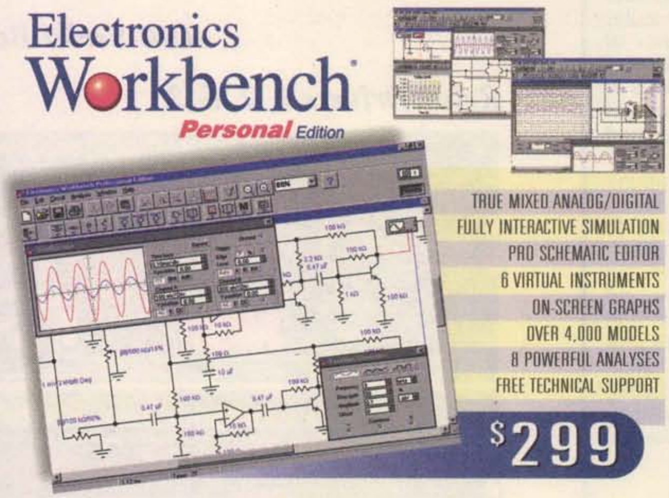
SUBSCRIBE TODAY!!

To Subscribe to NUTS & VOLTS

USA ONLY
$19.00 – 1 Year $35.00 – 2 Years $51.00 – 3 Years

MAILED FIRST CLASS — FOREIGN ONLY
$37.00 – Canada/Mexico $100.00 – Foreign/Air Mail
$50.00 – Foreign/Surface

Send payment to the address below or call 1-800-783-4624 and use your Visa or MasterCard.
Nuts & Volts Magazine, 430 Princeland Court, Corona, CA 91719

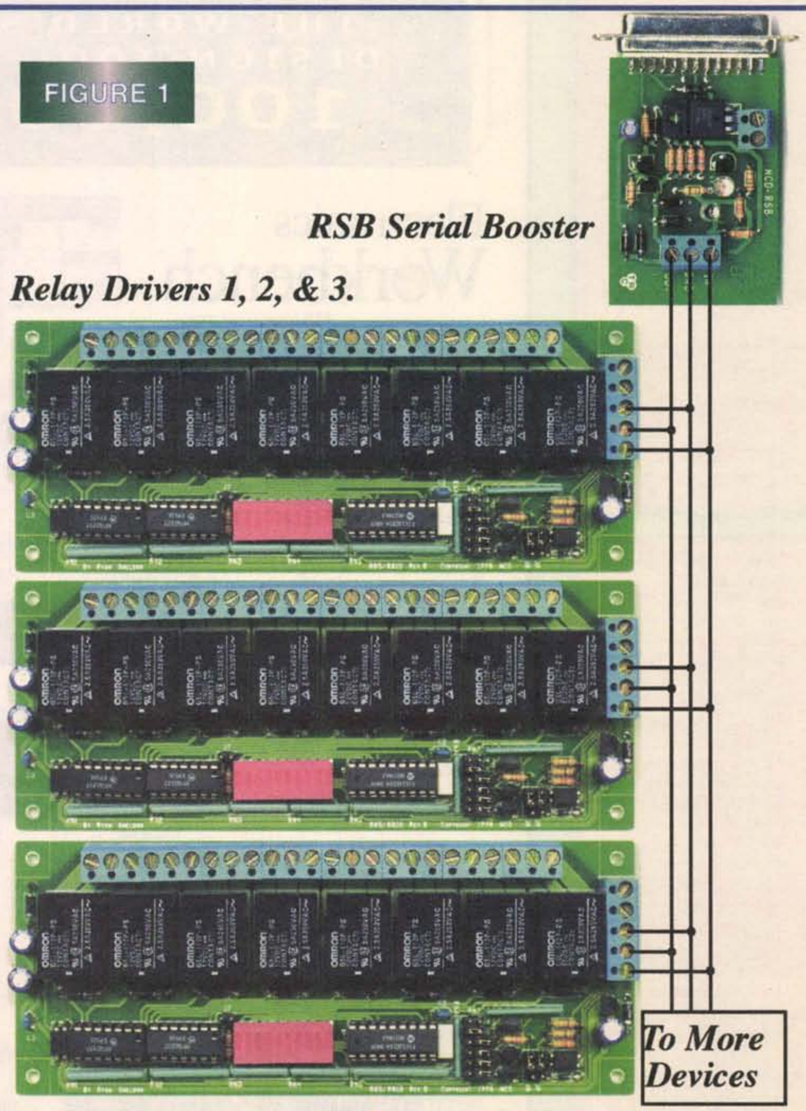


The Computer Controlled World: RS-232 Network Control Methods and Applications

Serial Killers

by Ryan Sheldon, National Control Devices (404) 244-2432 http://members.aol.com/ncdcat

FIGURE 1



Last month, I talked about controlling relays, graphic LCD displays, and A/Ds from a single serial port. While these are popular topics, I have received a large number of questions pertaining to general RS-232 communications. I want to clarify a few things in this month's article in hopes that readers get a better idea of RS-232 serial capabilities and limitations. In effect, I want my readers to know what inhibits (or kills) serial communications.

I will use the relay driver as an example to help clarify the questions I have received. Since this device is easy to program, readers will be able to concentrate on software and electrical issues rather than schematics and hardware. The relay drivers shown in this article will literally show you communication errors. By that, I mean corrupt data will usually appear as an unexpected relay activation/deactivation during a serial transmission.

How Far?

Perhaps the biggest question that I get with regard to RS-232 communications is distance. How far can you go? Well, there is no universal answer to this question. Some RS-32 peripheral devices may not operate beyond 12 feet, others may operate perfectly at a thousand feet. Distance is limited by four things:

1) Power: How powerful the port drivers are in your computer and attached device.
2) Speed: How fast you need to send and receive data.
3) Wire: Type of wire being used for communication.
4) Load: How much power is taken from the serial port from a driven device.

Power

The "RS" in RS-232 stands for "Recommended Standard" and, as such, is employed loosely by many computer manufacturers. While most desktop systems provide a powerful RS-232 signal (±10 to 12 volts at 3mA), many laptops make use of low-power circuitry that usually compromises communications strength (usually ±8 to 12 volts at 1mA).

Some microcontrollers (including the Basic Stamp and some of our own devices) conform to the RS-232 timing standard only. So instead of generating a ±12 volt signal, a standard logic-level (0/+5 volt) signal is used. A logic level RS-232 signal is not very powerful and should not be used for communicating data back to the computer beyond 10 feet. Without exception, all tested IBM-compatible PCs are capable of receiving logic level data without any problems. However, Macintosh systems require a true RS-232 signal for all inbound communications.

Speed

Another very important factor in RS-232 communications is speed (baud rate). The faster you send data out your serial port, the shorter the communication distance. At high baud rates, data pulses are very short and become very susceptible to noise. At low baud rates, an RS-232 signal can travel great distances. For example, I have tested 9600 baud over a distance of 1,000 feet with excellent results. Similar tests showed communications limitations of 60 feet at 115,200 baud.

Wire

Wire plays a very important role in RS-232 communications. I recommend the use of stranded insulated copper wire for best results. An average to heavy gauge (such as 12 or 10) is preferred. What you want to avoid is resistive and capacitive wire such as COAX and most stranded telephone cables.

Just keep in mind that anything that is capacitive corrupts data pulses by turning square waves into jagged waves. Resistive wire tends to weaken the signal strength. COAX is both resistive and capacitive, making it impossible to use for data communications unless used in combination with RF transceiver circuits such as those found in ethernet (thin-net) networking cards and hubs.

I have used stranded 15 gauge copper with good results, but would recommend a heavier wire if available. Solid copper telephone wire also works well and is often used by many readers in industrial installations.

Load

Say you have 12 light bulbs you want to power from a single battery. You attach the first bulb and the light is very bright. You attach the second bulb, and the first light gets a little dimmer, but both light brightly. As you keep attaching bulbs, the previously attached lights keep getting a little dimmer. The light bulbs are your load, and you may drive a few light bulbs at an acceptable brightness.

RS-232 communications suffers from the same problem. Except the RS-232 port is your battery and the device you want to drive is your light bulb. As you keep attaching devices to the serial port, the output power becomes weaker and weaker, until finally, the signal is corrupt and data can no longer control any device with reliability.

This scenario is more real than you might think. Many devices such as the relay controller discussed later in this article are optoisolated. In other words, they each have an invisible light bulb (LED) attached to the serial port used to protect the computer and the device from each other in the event of an electrical malfunction. LEDs will load down an RS-232 port, as well as a logic-level data signal from a BASIC Stamp. Though not recommended, a BASIC Stamp can usually drive five optoisolators from a single output pin without problems. Beyond that, the signal MUST be boosted.

RS-232 Network Solutions

Since RS-232 standards are employed randomly from manufacturer to manufacturer, and since our application requires speed, distance, and heavy loading, a supplemental circuit must be used to provide the necessary communications power.

The RSB serial booster shown in Figure 1 delivers high-current -3/+12 volt data at speeds up to 38.4K. The RSB can deliver data to 20 optoisolated devices and has been tested over a distance of 1,000 feet. The RSB is equipped with a DB-25 female connector for direct connection to your computer. You will need to supply a minimum of 15 volts to properly power the board.

The RSB has a simple three-terminal connector labeled IN, GND, and OUT. The ground is shared with the RS-232 ground of all networked devices. The OUT delivers high-current data to all attached devices. The IN connector accepts open collector data (which is equivalent to high-speed switch closures to ground) and converts it back into a compatible RS-232 data signal. This allows up to 16 devices to share a three-wire interface. Simply add devices as needed by chaining them together from this three-wire interface.

Protocol

Now that data has been fed to all three relay drivers, you can now speak to each driver board individually by using a very simple addressing system. To understand this system, you have to know that your computer is capable of sending ASCII characters 0 to 255 out the serial port.

Each relay driver board listens to a user-defined set of 16 ASCII characters. For instance, relay driver board #1 listens to ASCII characters 0 to 15. Relay driver board #2 listens to ASCII characters 16 to 31. Relay driver board #3 listens to ASCII characters 32 to 47. A set of four jumpers (J1-J4) defines which set of ASCII characters the relay driver board will respond to. See Figures 2, 3, and 4 for complete details on controlling each device.

ASCII Characters

One quick note worth mentioning about ASCII characters: ASCII characters are sent using their character codes. For example, the ASCII character "A" is sent using the ASCII character code 65. It is much easier to send

ASCII Character	Action	Special Notes
0	Turn Off Relay 1 on Relay Board 1	ASCII Characters 0 to 15 Control Relay
1	Turn Off Relay 2 on Relay Board 1	Driver Board #1. Jumpers J1-J4 Should
2	Turn Off Relay 3 on Relay Board 1	All Be Removed.
3	Turn Off Relay 4 on Relay Board 1	
4	Turn Off Relay 5 on Relay Board 1	
5	Turn Off Relay 6 on Relay Board 1	
6	Turn Off Relay 7 on Relay Board 1	Send Command 3 Times to Turn Off Relay 8
7	Turn Off Relay 8 on Relay Board 1	AND Report Status of all 8 Relays.
8	Turn On Relay 1 on Relay Board 1	
9	Turn On Relay 2 on Relay Board 1	
10	Turn On Relay 3 on Relay Board 1	
11	Turn On Relay 4 on Relay Board 1	
12	Turn On Relay 5 on Relay Board 1	
13	Turn On Relay 6 on Relay Board 1	
14	Turn On Relay 7 on Relay Board 1	Send Command 3 Times to Turn On Relay 8
15	Turn On Relay 8 on Relay Board 1	AND Report Status of all 8 Relays.

FIGURE 2

ASCII Character	Action	Special Notes
16	Turn Off Relay 1 on Relay Board 2	ASCII Characters 16 to 31 Control Relay
17	Turn Off Relay 2 on Relay Board 2	Driver Board #2. Jumpers J1 Should Be
18	Turn Off Relay 3 on Relay Board 2	Installed, J2-J4 Should Be Removed.
19	Turn Off Relay 4 on Relay Board 2	
20	Turn Off Relay 5 on Relay Board 2	
21	Turn Off Relay 6 on Relay Board 2	
22	Turn Off Relay 7 on Relay Board 2	Send Command 3 Times to Turn Off Relay 8
23	Turn Off Relay 8 on Relay Board 2	AND Report Status of all 8 Relays.
24	Turn On Relay 1 on Relay Board 2	
25	Turn On Relay 2 on Relay Board 2	
26	Turn On Relay 3 on Relay Board 2	
27	Turn On Relay 4 on Relay Board 2	
28	Turn On Relay 5 on Relay Board 2	
29	Turn On Relay 6 on Relay Board 2	
30	Turn On Relay 7 on Relay Board 2	Send Command 3 Times to Turn On Relay 8
31	Turn On Relay 8 on Relay Board 2	AND Report Status of all 8 Relays.

FIGURE 3

ASCII Character	Action	Special Notes
32	Turn Off Relay 1 on Relay Board 3	ASCII Characters 32 to 47 Control Relay
33	Turn Off Relay 2 on Relay Board 3	Driver Board #3. Jumpers J2 Should Be
34	Turn Off Relay 3 on Relay Board 3	Installed, J1,J3, and J4 Should Be Removed.
35	Turn Off Relay 4 on Relay Board 3	
36	Turn Off Relay 5 on Relay Board 3	
37	Turn Off Relay 6 on Relay Board 3	
38	Turn Off Relay 7 on Relay Board 3	Send Command 3 Times to Turn Off Relay 8
39	Turn Off Relay 8 on Relay Board 3	AND Report Status of all 8 Relays.
40	Turn On Relay 1 on Relay Board 3	
41	Turn On Relay 2 on Relay Board 3	
42	Turn On Relay 3 on Relay Board 3	
43	Turn On Relay 4 on Relay Board 3	
44	Turn On Relay 5 on Relay Board 3	
45	Turn On Relay 6 on Relay Board 3	
46	Turn On Relay 7 on Relay Board 3	Send Command 3 Times to Turn On Relay 8
47	Turn On Relay 8 on Relay Board 3	AND Report Status of all 8 Relays.

FIGURE 4

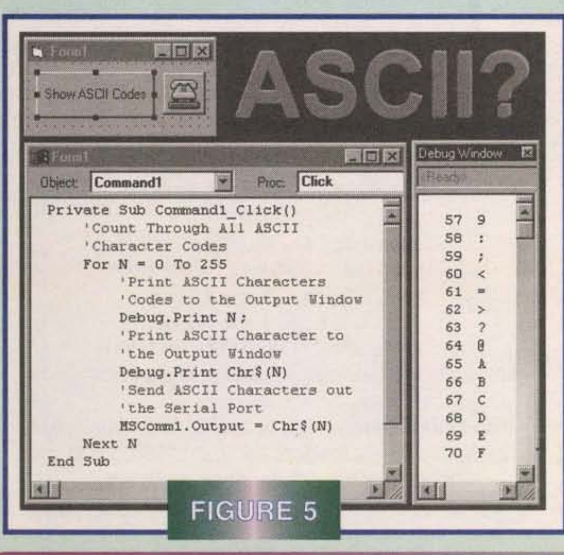


FIGURE 5

FIGURE 6

```
Project1 - Form1 (Code)
Check1                    Click

Private Sub Check1_Click(Index As Integer)
    'If Seleced(Index) Relay is Off
    If Check1(Index).Value = False Then
        'Turn Off Selected(Index) Relay
        MSComm1.Output = Chr$(Index)
    Else 'Otherwise, if Relay is On
        'Turn On Selected(Index) Relay
        MSComm1.Output = Chr$(Index + 8)
    End If
End Sub
```

FIGURE 7

```
Project1 - Form1 (Code)
Command1                  Click

Private Sub Command1_Click()
    'Send Command to Turn Relay 8 Off
    'Three Times in a Row.
    MSComm1.Output = Chr$(7)
    MSComm1.Output = Chr$(7)
    MSComm1.Output = Chr$(7)
    'The Relay Driver will Now Return
    'a Number from 0 to 255 representing
    'the on/off status of all 8 relays.
    'This Loop Will Wait for a Reply
    While MSComm1.InBufferCount <= 0
    Wend
    'Once a Reply has been received
    'The DIN variable will store the returned value
    DIN = MSComm1.Input
    'Update Check Marks Based on Status of Each Relay
    If (DIN And 1) / 1 = 1 Then Check1(0).Value = 1 Else Check1(0).Value = 0
    If (DIN And 2) / 2 = 1 Then Check1(1).Value = 1 Else Check1(1).Value = 0
    If (DIN And 4) / 4 = 1 Then Check1(2).Value = 1 Else Check1(2).Value = 0
    If (DIN And 8) / 8 = 1 Then Check1(3).Value = 1 Else Check1(3).Value = 0
    If (DIN And 16) / 16 = 1 Then Check1(4).Value = 1 Else Check1(4).Value = 0
    If (DIN And 32) / 32 = 1 Then Check1(5).Value = 1 Else Check1(5).Value = 0
    If (DIN And 64) / 64 = 1 Then Check1(6).Value = 1 Else Check1(6).Value = 0
    If (DIN And 128) / 128 = 1 Then Check1(7).Value = 1 Else Check1(7).Value = 0
End Sub
```

Reading Relays

FIGURE 8

```
Project1 - Form1 (Code)
Command2                  Click

Private Sub Command2_Click()
    'Send Command to Turn Relay 8 Off
    'Three Times in a Row.
    MSComm1.Output = Chr$(15)
    MSComm1.Output = Chr$(15)
    MSComm1.Output = Chr$(15)
    'The Relay Driver will Now Return
    'a Number from 0 to 255 representing
    'the on/off status of all 8 relays.
    'This Loop Will Wait for a Reply
    While MSComm1.InBufferCount <= 0
    Wend
    'Once a Reply has been received
    'The DIN variable will store the returned value
    DIN = MSComm1.Input
    'Update Check Marks Based on Status of Each Relay
    If (DIN And 1) / 1 = 1 Then Check1(0).Value = 1 Else Check1(0).Value = 0
    If (DIN And 2) / 2 = 1 Then Check1(1).Value = 1 Else Check1(1).Value = 0
    If (DIN And 4) / 4 = 1 Then Check1(2).Value = 1 Else Check1(2).Value = 0
    If (DIN And 8) / 8 = 1 Then Check1(3).Value = 1 Else Check1(3).Value = 0
    If (DIN And 16) / 16 = 1 Then Check1(4).Value = 1 Else Check1(4).Value = 0
    If (DIN And 32) / 32 = 1 Then Check1(5).Value = 1 Else Check1(5).Value = 0
    If (DIN And 64) / 64 = 1 Then Check1(6).Value = 1 Else Check1(6).Value = 0
    If (DIN And 128) / 128 = 1 Then Check1(7).Value = 1 Else Check1(7).Value = 0
End Sub
```

Reading Relays

FIGURE 9

the ASCII character codes (number 0 to 255) than it is to send the actual letters and numbers. Figure 5 demonstrates a quick program that lets you see the difference between ASCII characters and character codes. The demo program also shows how to send these codes out the serial port by making use of the MSComm Control under Visual Basic 5 Professional.

Controlling Relays

The RS-232 relay drivers shown in Figure 1 were designed for ease of use and simple troubleshooting. When properly powered, the heartbeat LED will begin flashing. The heartbeat LED indicates that power is properly applied and that the microprocessor is operating correctly.

As data is received, the "Data Received" LED will flash. This LED flashes any time data is detected on the serial port, regardless of which device the data is speaking to. This LED will flash on all three relay drivers during ANY data transmission.

The relay drivers shown in this article can be operated at 1200, 9600, and 19.2K baud (two stop bits at 19.2K baud) making them easy to interface to just about any computer or microcontroller. As control characters are received, you will hear the relays click on and off. A status LED will also indicate the on/off state of each relay on each board.

Figure 6 illustrates a simple program that I have written to control each of the three relay drivers from a Visual Basic application. Figure 7 shows just how easy it is to control these relay drivers. When a check mark box is clicked, this short program evaluates which box was clicked and the current status. This routine then sends an appropriate ASCII character out the serial port using the MSComm control.

Up to 16 relay controllers may be driven from a single RS-232 serial port. Each relay controller can report the status of the eight relays by sending the command to turn relay 8 on or off three times. This function is convenient for industrial applications that may require rock-solid reliable two-way communications.

Figures 8 and 9 show example code for reading the status of all eight relays. The read function requires that you send the command to speak to relay 8 three times in a row. Once issued, the relay controller will return a byte from 0 to 255. A 0 indicates all relays are off. A 255 indicates all relays are on. Any number in between represents the binary status of the relays. The final portion of this subroutine updates the check boxes providing a visual on-screen display of the current relay status.

Relay drivers have found their way into many control applications. They have been used to control lights, motors, speakers, sprinkler systems, alarm systems, and even explosives on many movie sets. Since it is easy to determine the on/off state of the relays from a remote location, many industrial users have been able to use them in a variety of manufacturing installations. Surprisingly, these relay controllers are most commonly used in factories that are in the process of automating old manufacturing equipment by adding centralized remote operation.

Thanks again for reading this month's "Computer Controlled World," and don't hesitate to call me at (404) 244-2432 or write me at ncdryan@aol.com if you have any questions. **NV**

Boards and Chips Available

Contact Ryan Sheldon
National Control Devices

Phone: **(404) 244-2432**
Fax: **(417) 646-8302**
E-Mail: **NCDRyan@aol.com**

http://members.aol.com/ncdcat/

The LCD Animator 128 is available exclusively to *Nuts & Volts* readers for just $199.00 if you mention this article when ordering.

reader FeedBack

Dear Nuts & Volts:

Regarding question #10982. Probably it is true that "blocking the unknowns with your Caller ID box is a very bad idea." But the question asked was "How" to do it, not whether sending a message to calls that come in identified only as "unknown."

What you get from a Caller ID modem is a text string. How you respond to it depends on how you interpret the text. Your Bel-Tronics box obviously sees "blocked" and responds "blah." All you have to do is recognize "unknown" and respond "blah." Yes, it's easier said than done, since probably you have no access to the Bel-Tronics innards. So, you call Terry Weeder 850-863-5723 and order his Caller ID interface kit.

This device will get the text string into your PC via the serial port. You get an old DOS box and write some QBASIC code to examine the text string for "unknown" or whatever, and respond to it in your own way, like dump a canned voice message on the line. It's called "systems injuneering" you've heard of it.

Jack Dennon
via Internet

Dear Nuts & Volts:

Answer correction to #9983 Sept. '98. When salt is dissolved in water it does not become more conductive, just the opposite. It creates a greater resistance thereby causing an increase in load on the power source.

As with any conductive material, as the temperature increases, the resistance decreases. All the meters giving a reading based on the voltage that is able to activate the meter. More resistance equals less voltage to the readout, less resistance equals more voltage to the readout.

A simple meter can be constructed with a six-volt lantern battery, a small voltmeter and two long pieces of copper wire (insulated w/ends bare).

Attach one connector of the meter to one post of the battery, one length of copper wire to the other connector on the meter. Connect the other length of copper wire to the other post of the battery. Place a known quantity of water in an insulated container. Place the bare ends of the copper wire in the container of water and note the voltage on the meter.

As you add and dissolve salt in the water, note that the voltage decreases. With a known quantity of water ratio to quantity of salt, one can translate the voltage reading to salinity in any known quantity of water wherein, there is an unknown quantity of salt. Keep in mind that other conductive solids in water will effect the meter readings.

Another simple method is to use a resistance or ohmmeter to test a know quantity of pure water and as you add known quantities of salt, note the resistance readings. Make a schedule that shows the resistance reading at various known quantities of salt. Use this schedule to determine salinity of like amounts of water as test samples. Again, keeping in mind that other unknown dissolved conductive solids will effect the reading.

If one is testing seawater, the reading will give you more information concerning the other dissolved solids, as seawater is commonly 35,000ppm salt or approximately 3.5%. The water in the Great Salt Lake is so much greater than even seawater that is all but impossible to sink in it.

Jim West
Dale City, VA

Dear Nuts & Volts:

On page 17 of the Nov. '98 issue of *Nuts & Volts*, Emil Rossdeutscher writes a letter about another potential Y2K problem. He is not quite correct, but he brings up, unintentionally, a different problem altogether.

Emil states that chips using a mod 4 method to determine leap years "[...] are an actual Y2K problem. They will tell you that the last year of the 20th Century is a Leap Year, which it is not." The truth is, 2000 will be a leap year, so these chips will function correctly after all.

The problem is, as you might guess, that some people know 2000 is a leap year and some don't. People writing software and making hardware may or may not know this, and may or may not make their systems obey the convention.

So January 1st is not the only day in 2000 that we should be concerned about.

Russ Perry, Jr.
Arlington Heights, IL

Dear Nuts & Volts:

In the Nov. '98 issue, there is a letter from Emil Rossdeutscher about the year 2000 not being a leap year. Sorry, that is in error.

You see, there are three conditions to fulfill. First, the obvious one, that any year divisible by four is a leap year. Next, the exception.

Any century year is not a leap year. But, there is a third condition, an exception to the exception — that is, if a century year is divisible by 400, it is a leap year. This is to correct for the "overcorrection" in the century year rule. If you strictly adhere to that rule, you end up slightly short overall.

In other words, the year 2000 is indeed a leap year, despite being a century year.

Charles W. Shults III
Orlando, FL

by Chuck Baird

A New Use for an Old Switch

I have used a PC fax/modem for several years and like the convenience of sending faxes directly from my word processor without having to print them. However, I have never been happy using the modem to receive faxes, both because it ties up the computer while the fax is coming in, and because it is necessary to leave the computer and fax software running whenever a fax might arrive. Given these reasons and the frequent need to send non-computer-generated documents, I finally bought a stand-alone fax machine.

Sharing a residential phone line with a fax machine can also be a minor pain, even with a "smart" switch (about $80.00, more than I wanted to spend) that is supposed to recognize the type of an incoming call and route it appropriately. Add a second phone line (due to an Internet account and the desire to stay married) and the stage is set: manage two phone lines, a heavily used modem, an occasional outbound fax via modem, in and out faxes on the stand-alone machine, and do it without using an automatic switch.

All this, plus honor the small print in the fax machine's manual: don't share the fax machine's phone line with a modem because they might try to sing duets during data transfers. Also, since a manual switch was my preference, it would be good to have some indicator lights to remind me to set everything back to "normal" any time I changed it.

After pricing multiple pole, multiple throw switches, and not wanting to wait for mail order delivery, I decided to try to come up with an alternative solution. Looking through my junk box for possible switching components, I came across an old printer A/B box which was designed to allow one computer to use two printers or two computers to use one printer.

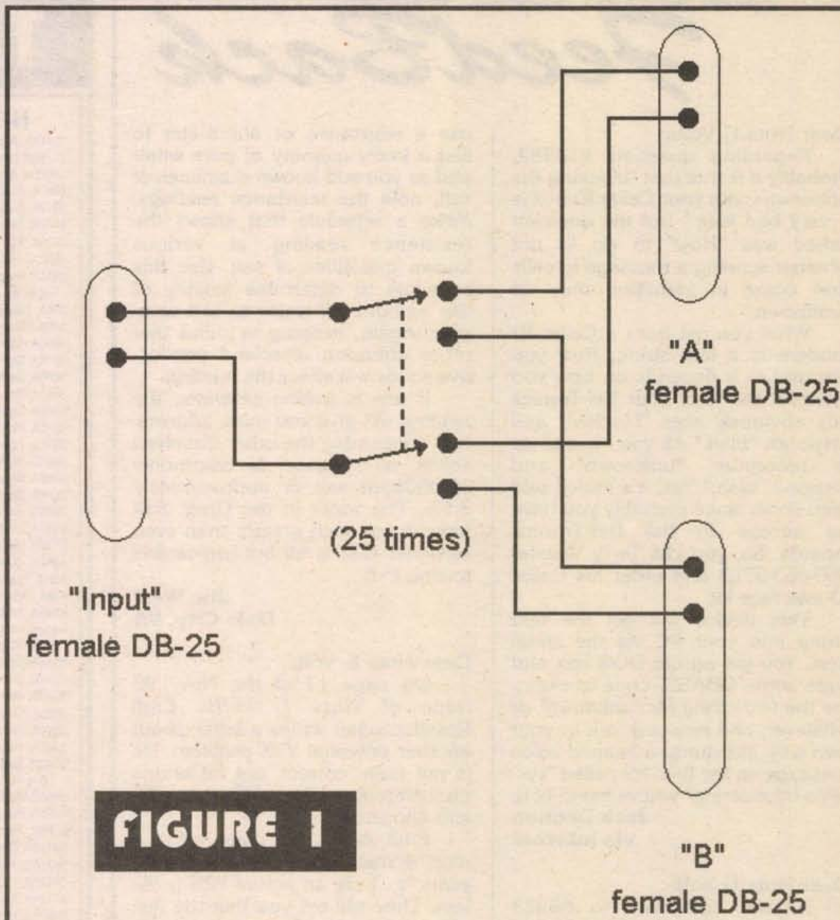


FIGURE 1

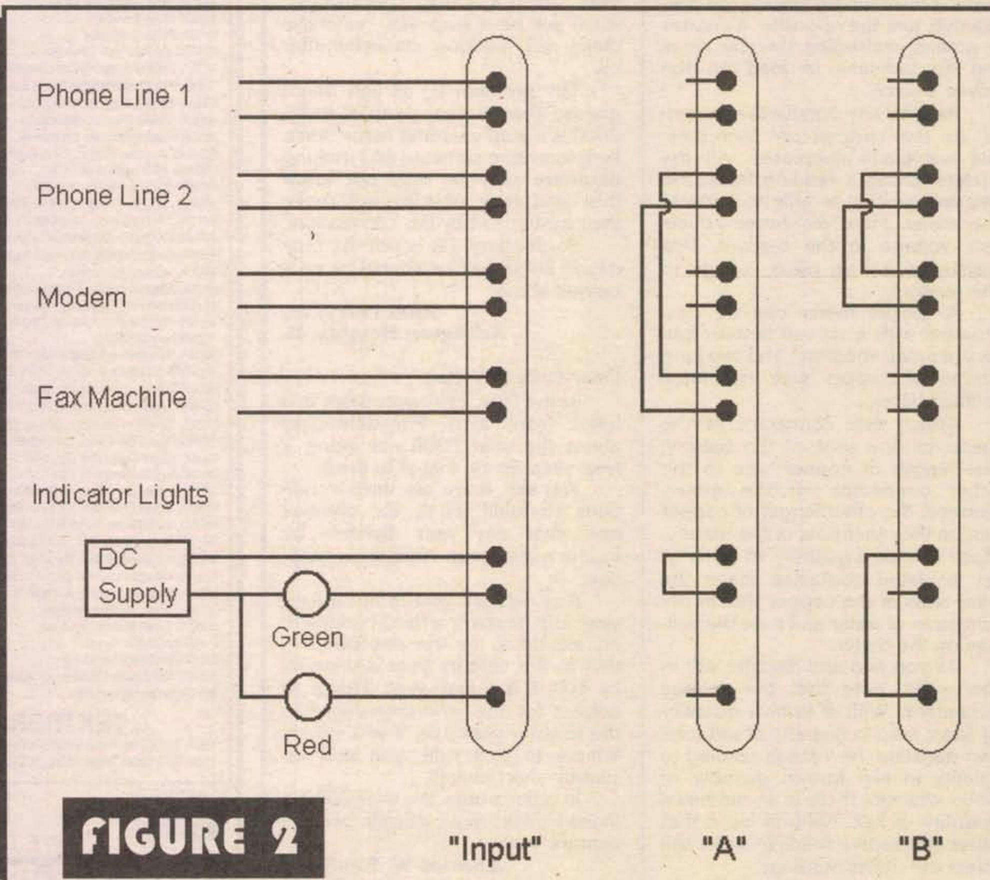


FIGURE 2

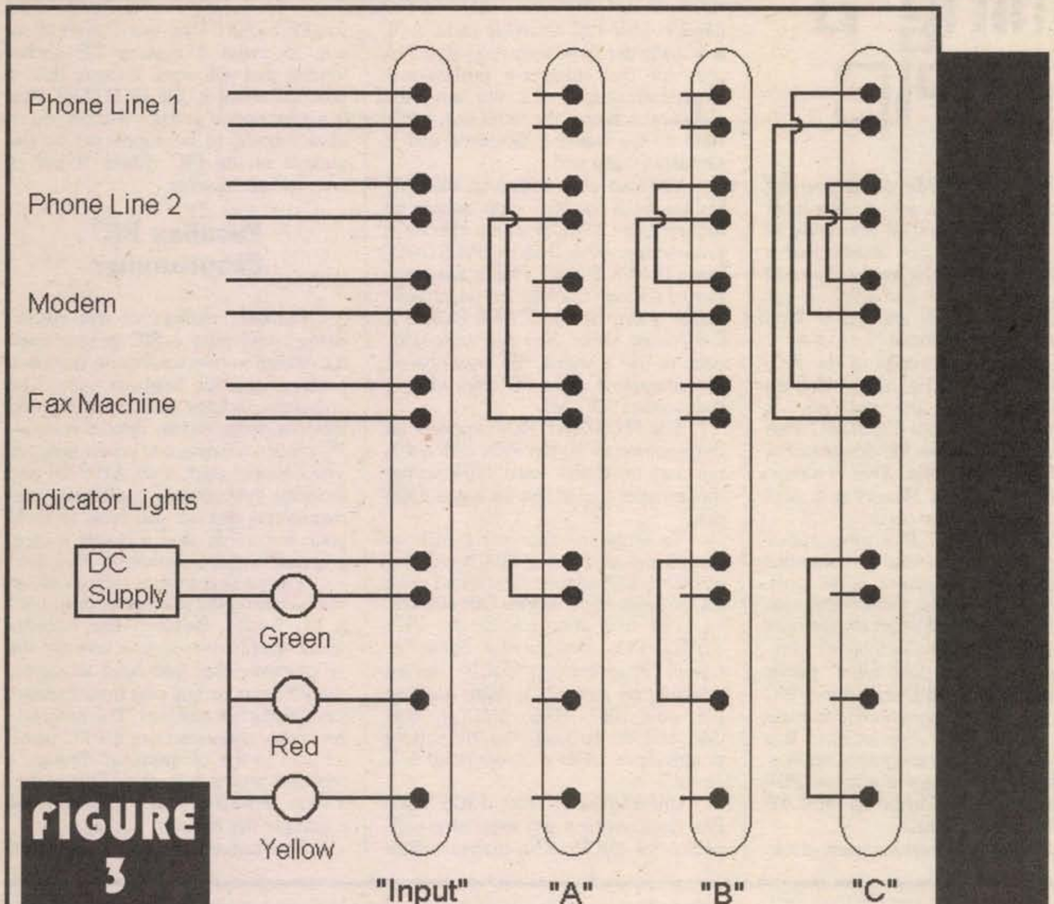


FIGURE 3

It consists of a 25-pole, double-throw switch in a case and had three female DB-25 connectors on the rear (input/A/B) and a two position switch (A/B) on the front (see Figure 1). As I was starting to cannibalize the switch for this project, it dawned on me that there was a much better way to utilize the A/B box.

Since there are 25 switched lines (some A/B boxes switch fewer, sometimes 24) and an inexpensive DB-25 connector on each end, I decided to use the set of 25 lines as a sort of bus. I connected the pairs of wires for each of the two outbound phone lines, the modem ("wall" jack), the fax machine ("wall" jack), and the indicator lights wiring to arbitrary pins of a male DB-25 and plugged it onto the "input" connector.

I then wired another DB-25 with jumpers which connected these "bus" wires together in the desired combination and plugged it onto the "A" connector. When the switch is in the "A" position, this connector routes the inputs appropriately.

I wired a third male DB-25 with a different jumper arrangement and plugged it onto the "B" connector, and the project was done. Critical issues are using a DC source for the lamps and observing polarity of the phone lines throughout. See Figure 2.

In this arrangement, line one remains unswitched and goes to the various extension telephones and the answering machine elsewhere in the house. Line two switches between the fax machine and the modem, with a green light indicating the fax machine is able to receive calls (the normal state of things), and a red light meaning that faxes cannot be received. When I get off of the Internet in the wee hours of the morning, the red light is supposed to remind me to flip the switch.

Later, I came across a surplus A/B/C printer switch box which I now use in place of the original A/B switch. They work the same, but the A/B/C switch uses a 25-pole, three-throw switch and has a third output connector and switch position. My previously wired connectors all work on it without modification, plus I now have an additional switch position which provides a third wiring arrangement. My current configuration is shown in Figure 3.

This wiring arrangement switches both phone lines. In the "A" position, extension phones are on line one, the fax machine is on line two, and the green light is on. In the "B" position, extension phones are on line one, the modem is on line two, and the red light is on. In the "C" position, both extension phones and the fax machine are on line one, the modem is on line two, and the yellow light is on.

This third position allows me to send or receive a fax manually during a voice conversation on line one, as well as to exchange faxes between the modem and fax machine for testing, or to inspect print and scan quality. The reason for not having the fax machine on line one under normal conditions is to keep it from answering incoming voice calls.

I have found this solution works well, and the total new parts cost was four male DB-25 connectors at 39 cents each (optional hoods are considerably more expensive). I can also wire additional connectors at any time to reconfigure the switch. Furthermore, although I hope my shared printer days are over, the original A/B and A/B/C boxes are unmodified and as good as ever. **NV** by Chuck Hellebuyck

Programming a Microchip PIC

I'm probably safe in assuming that you've heard about the Microchip PIC microcontrollers. You may have surfed a few websites or read an article about them. You might have even used a BASIC Stamp and learned it is built around a Microchip PIC microcontroller. No matter what road you took to understand what a Microchip PIC is, at some point you'll want to get your hands on a PIC and actually program it.

To program a PIC requires a PIC part, a program, and a PIC programmer. Because Microchip PICs are so popular, you have many programmer options to choose from. To cover every option available would be impossible. Instead, I decided to focus on four programmer packages to get you started. From these, you should be able to guide yourself down the path that is right for you. Let's start at the top with Microchip.

Microchip PICSTART Plus

As the PICs have evolved, so have the programmers from Microchip. The PICSTART Plus is Microchip's current "low-cost" offering for development work. It could be called affordable at $199.00, but you can usually find a deal through Microchip that will let you buy it for $149.00. Just keep an eye on their website or contact a local Microchip representative.

The main advantage to the PICSTART Plus is the support from Microchip. When any new part is released, free updated PICSTART Plus software is available for download at the Microchip website. This is important to me because Microchip is constantly releasing new parts.

The PICSTART Plus programmer is very easy to use and is controlled through your computer's serial port. The PICSTART Plus also comes with everything you need to get started right away (except a Windows-based computer). The serial port cable, power supply, and a 16F84 flash memory PIC that can be reprogrammed multiple times are included. Also included is a CD that has sample programs, application notes, data sheets in acrobat .PDF format, and the Microchip MPLAB simulator ready to install.

MPLAB is a great environment to develop your PIC assembly code in. It is actually the same software Microchip uses for their high-cost professional emulation system. It's the emulator software without the emulator hardware so it's called a simulator and it simulates really well.

You can also download MPLAB for free from the Microchip website or request the CD-ROM if you choose a programmer other than the PICSTART Plus. The PICSTART Plus is fully supported through the MPLAB which simplifies using the PICSTART Plus to a few mouse clicks. You can write your code or use a sample file, assemble it, and program it into a PIC part without ever leaving MPLAB.

The PICSTART Plus supports all the eight-pin to 40-pin PICs with a 40-pin zero insertion force (ZIF) socket that accepts dual in-line packages (DIP) only.

To program other parts such as surface-mount devices (SMD) requires a SMD to DIP adapter. You'll find most PIC programmers include DIP sockets.

The one drawback to the PICSTART Plus involves the Serial In-Circuit Programming (SICP) feature available on most PICs. With just five PIC pins RB7, RB6, /MCLR, Vdd (5V), and Vss (ground), the PIC can be programmed while still connected in a circuit.

Unfortunately, the PICSTART Plus does not have any expansion connector for (SICP). The drivers within the PICSTART Plus won't even allow you to make a custom ZIF socket jumper that will work. Despite this, if you can afford it, the PICSTART Plus is a great option and you'll know you're always going to be supported by the makers of the PIC. Check it out at www.microchip.com.

Parallax PIC Programmer

Parallax, makers of the BASIC Stamp, also offer a PIC programmer. It's offered in two versions: a complete package and the hobbyist pack. The complete package costs $199.00 and includes programmer, printed manual, PC cable, software, and power adapter. The hobbyist pack costs $109.00 and includes programmer, software, and manual on disk so you have to build your own cable, find a power source, and read or print the manual from disk.

The programmer is pretty easy to use so having the manual on disk is not a big hassle. Parallax also includes some sample files so you can use the programmer, but you have to supply the PIC part or buy one from Parallax since that's not included. The programmer cable connects from the PC parallel port to the programmer through a modular phone jack plug. This makes it more difficult to find your own cable if you get the hobbyist package.

You can use a 25-pin header to

modular jack converter (RadioShack part no. 276-1405a) on the PC parallel port and a normal phone cable to connect the programmer. With the hobbyist package, you also have to supply 12-18 volts from a power supply or power adapter.

I just used my Datarase EPROM eraser's power adapter. The Parallax programmer has separate 18-pin and 28-pin DIP sockets to cover the most common packages.

To program larger or smaller pin count packages requires additional adapters. Parallax has the adapters for an additional cost. Parallax's programmer has an expansion connector that is used for SICP and adapters. I like that feature.

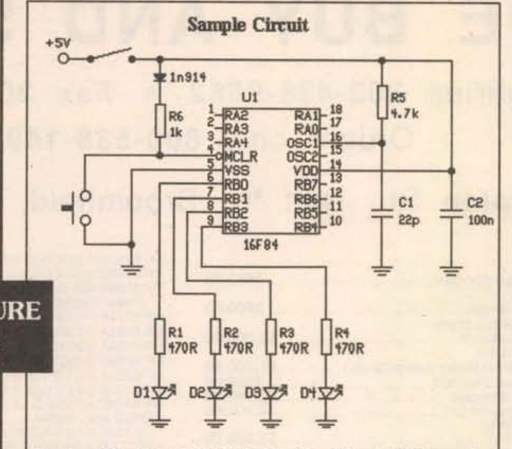


FIGURE 1

Designed by David Tait, Modified by Chuck Hellebuyck

Parallax's programmer relies on both hardware and software (called firmware) upgrades to support new parts from Microchip. Update packages currently cost $49.95. The programmer software runs on DOS or in a DOS window.

With the added costs associated with this programmer, you may wonder why I mention it. If you're just writing PIC code, then the PICSTART Plus is a more complete programming package. However, if you're writing BASIC Stamp 1 (BS1) code, the Parallax programmer has a hidden feature. It will take your BS1 code and program a 16C58A PIC with a simple ALT-I key press. For a real novice, this can be a great feature.

Develop your code using a BS1. When you're done, disconnect the BS1 cable and replace it with the Parallax programmer. Install a PIC 16C58A into the programmer and then press ALT-I instead of the ALT-R BS1 editor command. It will program the 16C58A with the BS1 code. Install the 16C58A into a circuit with resonator, /MCLR pullup resistor, Vdd (five volts), Vss (gnd), and your BS1 program is now running in a PIC. You can check out the Parallax programmer at www.parallaxinc.com.

microEngineering Labs EPIC Plus Pocket PIC Programmer

microEngineering Labs, Inc., offers a lower-cost PIC programmer. It's a very small package that will actually fit in your pocket (hence the name Pocket PIC Programmer). The programmer will run off two nine-volt batteries which makes it very portable. It costs $59.95 for the fully assembled programmer or you can buy just the circuit board, parts list, and software for $34.95. An optional AC adapter is available for $9.95. The original software included is a DOS version, but a new WIN95/NT may now be available.

The programmer is controlled through the PC parallel port. An optional cable costs $9.95, but any standard parallel cable should work. The programmer uses the Serial In-Circuit Programming (SICP) feature that most PICs offer. The 16C5X parts are the only PICs that don't support the SICP feature so the EPIC programmer does not support these parts.

The programmer has an 18-pin DIP socket built in which programs eight- and 18-pin PICs.

To program larger pin count PICs, or SMD PICs will require additional adapters.

The EPIC programmer has an expansion connector similar to the Parallax programmer. microEngineering Labs offers several varieties of adapters including a SICP cable/socket adapter for 16F84 flash PICs. microEngineering Labs is the same company that offers the PicBasic compilers for programming PICs in a higher level BASIC language.

The PicBasic compilers work off an instruction list very similiar to the BASIC Stamp commands. This allows you to write code in PicBasic and never have to learn Microchip assembly.

I hope to cover programming with PicBasic in another *Nuts & Volts* article as I'm quickly running out of room here. microEngineering Labs does update their programmer software to keep up with the latest PIC parts. It is available for a small update fee. The EPIC programmer is a handy little programmer. You can check out the EPIC programmer at www.melabs.com.

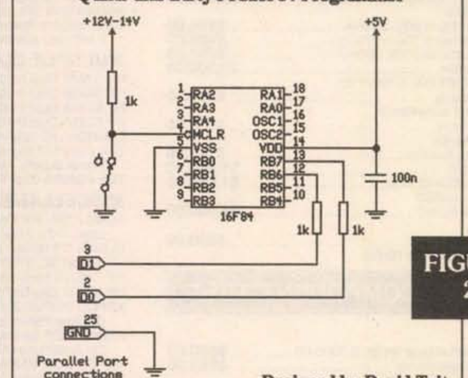


FIGURE 2

Designed by David Tait

Ultra Cheap PIC Programmer

That title probably got your attention. As mentioned earlier, most of the PICs offer the SICP feature and you can use that to your advantage. With the right software and simple hardware, it's possible to program a PIC via three pins of your PC parallel port and a 12V/5V power supply. Thanks again to the popularity of Microchip PICs, you can find free software and hardware schematics to do this on the Internet.

One good location is David Tait's page at www.man.ac.uk/~mbhstdj/piclinks.html. His site has links to several simple PIC programmers. I built David's "Quick and Dirty" programmer for the 16F84 PIC. There are so many PIC links on David's site that it may be difficult to find the programmer I refer to. The file that contains everything you want — including the control software — is "pic84v05.zip." To make things easier, I've added a link on my website (www.elproducts.com) so you can download the correct file.

The programmer circuit contains only a few parts and connects to the PC parallel port. The software runs in DOS or a DOS window. I built the programmer in about 20 minutes on a proto-board. David includes a sample program to test the programmer with called "walk.hex." It illuminates LEDs in a back and forth motion.

Build the sample circuit (Figure 1) with the 16F84 and LEDs in place. I added a diode to David's schematic to protect the five-volt supply and a /MCLR reset switch. Connect the Quick and Dirty programmer circuit (Figure 2) to the sample circuit per the schematic.

With five volts on Vdd and 12 volts at the /MCLR pin, enter the command "MYPP WALK.HEX" at the DOS prompt. When the program displays "Insert PIC," reset the /MCLR pin to ground and release. That puts the PIC in program mode. Press the PC enter key and the PIC will get programmed. Disconnect 12 volts and reset /MCLR again.

If you're successful, the LEDs will start scrolling back and forth. I was really impressed with how easy it was to build this programmer. It cost me nothing because I had the parts, but it shouldn't cost more than $10.00. It really worked great although it could only program the PIC, not read or verify the programmed PIC. You can't get much cheaper than this.

Summary

For any PIC programmer, your programs have to be in HEX format (designated INHX8M by Microchip). Almost any PIC assembler will create that file format. The MPASM assembler from Microchip is my choice. It comes with MPLAB.

Programming PICs is fun and easy. Hopefully, I've made your path to programming PICs a little easier as well. The toughest part about PICs is writing the programs. If you're not familiar with Microchip assembly code, it will take a little while to figure it out.

I find it very powerful and worth the effort to learn. There are only 35 different commands to remember for the most common parts. If you're a real beginner or moving up from the BASIC Stamps, then PicBasic programming language may be the route for you. I'll talk more about this in another article. Until then, pick your PIC programming path and have fun. **NV**

Comments or questions can be sent to the author at chuck@elproducts.com. Be sure to check out Chuck Hellebuyck's Electronic Products website at: www.elproducts.com.

Write In 211 on Reader Service Card.

90 DAY WARRANTY PARTS AND LABOR • 10 DAY INSPECTION
TEST EQUIPMENT WANTED CALL OR FAX LIST • OPEN ACCOUNTS

AUDIO & BASEBAND

SPECTRUM ANALYSIS

HP 3586C Selective Level Meter, ... $1,500.00
50 Hz-32.5 MHz, 50 & 75 ohms
TEK 7L5/L3/R7603 Spectrum Analyzer, ... $1,500.00
20 Hz-5 MHz, 10 Hz min. res.,w/frame

DISTORTION ANALYZERS

HP 339A Distortion Analyzer, built-in low distortion osc. $1,250.00
HP 8903A-001 Audio Analyzer, ... $2,000.00
20 Hz-100 kHz; rear panel input
HP 8903B-001,013,051 Audio Analyzer, ... $2,500.00
20 Hz-100 kHz; C-message, CCITT
TEK DA4084 Programmable Distortion Analyzer $1,000.00

RMS VOLTMETERS

FLUKE 8920A True RMS Voltmeter, ... $450.00
180 uV-700 V, 10 Hz-20 MHz
FLUKE 8922A True RMS Voltmeter, ... $450.00
180 uV-700 V, 2 Hz-11 MHz
HP 209A Sine/Square Wave Generator, ... $225.00
4 Hz-2 MHz, 5 VRMS max.

OSCILLATORS

HP 3336C Synthesizer/ Level Generator, 10 Hz-21 MHz $1,400.00
TEK SG5010 Programmable Oscillator, 10 Hz-163.8 kHz $2,750.00
TEK SG502 Sine/Square Osc., ... $200.00
5 Hz-500 kHz, 70 dB step atten.,TM500

MISCELLANEOUS

HP 3575A-001 Phase-Gain Meter, ... $850.00
1 Hz-13 MHz, dual display option
HP 461A Amplifier, 20/40 dB, ... $125.00
1 kHz-150 MHz, 0.5 V/50 Ohms
KROHN-HITE 3103 High/Low Pass $400.00
Filter, 10 Hz-3 MHz, 24 dB/octave
KROHN-HITE 3202 Dual HP/LP/BP/BR $450.00
Filter, 20 Hz-2 MHz, 24 dB/octave
KROHN-HITE 3342R Dual HP/LP Filter, ... $900.00
0.001 Hz-99.9 kHz, 48 dB/octave
KROHN-HITE 3750 LP/HP/BP/BR Filter, ... $600.00
0.02 Hz-20 kHz, 6/12/18/24 dB/oct.
KROHN-HITE DCA-10R 10 Watt $450.00
Amplifier, 20 dB gain, DC-1 MHz, 600-1000 Ohms
ROCKLAND 852 Dual Highpass/ $1,000.00
Lowpass Filter, 0.1 Hz-111 kHz
TEK AF501 Tunable Bandpass Filter / $300.00
Amplifier, 3 Hz-35 kHz
TEK AM502 Differential Amplifier, ... $475.00
0.1 Hz-1 MHz, TM500 series

RF & MICROWAVE

SPECTRUM ANALYZERS

HP 11517A/19A/20A Mixer Set, ... $600.00
18.0-40.0 GHz, for HP 8555A/8569A
HP 11970A WR28 Harmonic Mixer, 26.5-40 GHz $1,100.00
HP 11970K WR42 Harmonic Mixer, 18.0-26.5 GHz $1,100.00
HP 11970Q WR22 Harmonic Mixer, 33-50 GHz $1,400.00
HP 11970U WR19 Harmonic Mixer, 40-60 GHz $1,400.00
HP 8444A-059 Tracking Generator, ... $1,250.00
0.5-1500 MHz, for 8554,8568,etc.
HP 8445B Preselector, 1.8-18.0 GHz, for HP 8555A $650.00
HP 853A-001 Spectrum Analyzer $1,250.00
Display, bench/rack mount config.
HP 8565A-100 Spectrum Analyzer, ... $4,500.00
10 MHz-22 GHz, 100 Hz min. res.
HP 8566B Spectrum An., ... $37,500.00
100 Hz-22 GHz, HP calibration certificate
HP 8569B Spectrum Analyzer, ... $7,500.00
10 MHz-22 GHz, 100 Hz min.res.bw.
TEK 7L14-039/7603 Spectrum Analyzer, ... $2,500.00
1 kHz-2.5 GHz, 30 Hz min. res. bw.
TEK TR503 Tracking Generator, ... $850.00
0.1-1800 MHz, for 492/4/5/6
TEK WM782V WR15 Harmonic Mixer, 50-75 GHz $1,500.00

NETWORK ANALYZERS

HP 85021C Directional Bridge, ... $1,000.00
0.01-18 GHz, 33 dB dir,for 8755/6/7
HP 8753A Network Analyzer, 300 kHz-3 GHz $7,500.00
HP 8756A Scalar Network Analyzer $2,500.00

SIGNAL GENERATORS

FLUKE 6060A Synthesized Signal Gen., ... $2,750.00
0.1-1050 MHz, 10 Hz res., GPIB
FLUKE 6060A/AN Synthesized $1,750.00
Signal Gen.,10 kHz-520 MHz, 10 Hz res.,GPIB
FLUKE 6062A Synthesized Signal Gen., ... $5,000.00
0.1-2100 MHz, 10 Hz res., GPIB
GIGATRONICS 1018 Synthesized $4,500.00
Signal Gen., 50 MHz-18 GHz, 1 MHz res.
GIGATRONICS 600/10-18 Synthesized $2,500.00
Source, 10-18 GHz, 1 MHz res., GPIB
GIGATRONICS 600/6-12 Synthesized $2,500.00
Source, 6-12 GHz, 1 kHz res., GPIB
GIGATRONICS 875/50 Levelled Multiplier, ... $2,500.00
x4, 50.0-75.0 GHz output, -3 dBm
GIGATRONICS 875/86 Levelled Multiplier, ... $3,750.00
26.5-40.0 & 50.0-75.0 GHz outputs
GIGATRONICS 900/2-8 Synthesized $3,000.00
Signal/Sweep Gen., 2-8 GHz, 1 kHz res.,GPIB
HP 11720A Pulse Modulator, 2-18 GHz, 80 dB on/off ratio $450.00
HP 85100V Frequency Mult., ... $3,750.00
10-15 GHz in / 50-75 GHz out >0 dBm
HP 8640B-001,002 Signal Gen., ... $1,750.00
0.5-1024 MHz, AM, FM, var. audio osc.
HP 8656A Synthesized Signal Gen., ... $2,500.00
0.1-990 MHz, 100 Hz res., HPIB
HP 8657A-002 Signal Generator, ... $3,250.00
0.1-1040 MHz, 10 Hz res., HPIB
HP 8660C/86602B-002 Synth. Sig. Gen., ... $3,250.00
1-1300 MHz, FM / Phase mod. w/86635A
HP 8660C/86603A-002 Synthesizer, ... $4,500.00
1-2600 MHz, FM / Phase Mod., w/86635A
HP 8672A Synthesized Signal Generator, 2-18 GHz $6,000.00
HP 8684B Signal Generator, ... $3,500.00
5.4-12.5 GHz, AM, WBFM, Pulse

SWEEP GENERATORS

HP 8350A/83545A-002 Sweep Oscillator, ... $4,000.00
5.9-12.4 GHz, 70 dB step attenuator
HP 8350B/83592B-002 Sweep Generator, ... $14,500.00
10 MHz-20 GHz, 70 dB step attenuator
HP 83545A RF Plug-in, 5.9-12.4 GHz, +17 dBm levelled $1,750.00
HP 8601A Generator/Sweeper, ... $400.00
0.1-110 MHz, +20 dBm levelled
HP 8620C Sweep Oscillator Frame $550.00
HP 86222B-002 RF Plug-in, ... $1,500.00
10-2400 MHz, +13 dBm levelled, 70 dB atten.
HP 86230B RF Plug-in, ... $500.00
1.8-4.2 GHz, +10 dBm unlevelled
HP 86235A-001,002 RF Plug-in, ... $600.00
1.7-4.3 GHz, +14 dBm levelled, 70 dB atten.
HP 86240C RF Plug-in, 3.6-8.6 GHz, +16 dBm levelled $700.00
HP 86241A-001 RF Plug-in, 3.2-6.5 GHz, +8 dBm levelled $300.00
HP 86242D-004,008 RF Plug-in, ... $300.00
5.9-9.0 GHz, +10 dBm levelled
HP 86250D RF Plug-in, 8.0-12.4 GHz, +10 dBm levelled $500.00
HP 86260A RF Plug-in, 12.0-18.0 GHz, +10 dBm unlevelled $500.00
HP 86260A-H04 RF Plug-in, ... $500.00
10.0-15.0 GHz, +10 dBm unlevelled
HP 86290A RF Plug-in, 2.0-18.0 GHz, +7 dBm levelled $1,750.00
HP 86290B RF Plug-in, 2.0-18.6 GHz, +10 dBm levelled $2,000.00
WAVETEK 962 Sweep Generator, ... $1,500.00
1.0-4.0 GHz, markers, +12 dBm unlvld.
WILTRON 6619A Sweep Generator, ... $1,500.00
2-8 GHz, +10 dBm levelled

POWER METERS

ANRITSU MA72B Power Sensor, ... $200.00
-20 to +20 dBm, 0.01-18 GHz
ANRITSU MP-81B/ML-83A Power Meter, ... $2,500.00
75-110 GHz (WR10), -20 to +20 dBm
BOONTON 4200-01A,03/&-4A x2 Dual $1,500.00
Channel Microwattmeter, w/(2) 1 MHz-7 GHz sensors
BOONTON 42B/41-4B Analog Power $375.00
Meter, with 1 MHz-12 GHz sensor
BOONTON 42B/41-4E Analog Power $500.00
Meter, with 1 MHz-18 GHz sensor
GENERAL MICROWAVE 476/4240A $300.00
Power Meter & Sensor, 0.01-18 GHz, -35 to +10 dBm
HP 435B/8482B Power Meter, ... $1,800.00
0 to +43 dBm, 100 kHz-4.2 GHz
HP 435B/8482H Power Meter, ... $950.00
0.1-4200 MHz, -10 to +34 dBm
HP 436A Power Meter $900.00
HP 8477A Power Meter Calibrator, for HP 432 series $500.00
HP K486A WR42 Thermistor Mount, ... $350.00
18.0-26.5 GHz, for 432 series
HP Q8486A Power Sensor, ... $1,500.00
33.0-50.0 GHz, WR22, for 435/6/7/8
HP R486A WR28 Thermistor Mount, ... $350.00
26.5-40 GHz, for 432 series

RF MILLIVOLTMETERS

BOONTON 92B-opt.05 RF Millivoltmeter, ... $500.00
10 kHz-1.2 GHz, 75 Ohms scale
RACAL 9303 TRMS Level Meter, ... $875.00
10 kHz-2 GHz, -77 to +23 dBm, GPIB

AMPLIFIERS, MISCELLANEOUS

AMPLIFIER RESEARCH 1W1000 .... $650.00
Amplifier, 30 dB gain, 1-1000 MHz, 1 Watt output
BOONTON 82AD-opt.01A Modulation $900.00
Meter, AM, FM, 10-1200 MHz, GPIB
HP 11715A AM/FM Test Source $1,600.00
HP 415E SWR Meter $300.00
HP 465A Amplifier, 20/40 dB, ... $125.00
5 Hz-1 MHz, 1/2 Watt/50 Ohms
HP 8447A Amplifier, 20 dB, ... $375.00
0.1-400 MHz, 5 dB NF, +6 dBm output
HP 8447E Amplifier, 22 dB, ... $750.00
0.1-1300 MHz, +13 dBm output
HP 8447F Preamplifier / Power Amplifier, 0.1-1300 MHz $1,200.00
HP 8901A Modulation Analyzer, 150 kHz-1300 MHz $3,000.00
HP 8901B-1,2,3 Modulation An., ... $4,000.00
0.15-1300 MHz, rear input, OCXO, ext.LO
HP 8970A Noise Figure Meter $5,000.00
HUGHES 1177H02F000 TWT $1,500.00
Amplifier, 4.0-8.0 GHz, 10 Watts output
MICROWAVE SEMI.CORP. MC5112 .... $275.00
Noise Source, 25.5 dB ENR, 1.0-12.4 GHz, N(m), +28 VDC
ROHDE & SCHWARTZ ESH2 .... $5,000.00
Test Receiver, 9 kHz-30 MHz

COAXIAL & WAVEGUIDE

AMERICAN NUCLEONICS AM-432 .... $95.00
Cavity Backed Spiral Antenna,LHC, 2-18 GHz,TNC(f) *NEW*
FXR/MICROLAB S3-02N Triple $125.00
Stub Tuner, 200-1000 MHz, 100 Watts max., N(m/f)
GR 874-LTL Constant Impedance $400.00
Trombone Line, 0-44 cm, DC-2 GHz
GR 900-Q GR900 14mm Interseries Adapters $125.00
HP 11590A-001 Bias Network, 1.0-18.0 GHz, APC7 .... $450.00
HP 11612A Bias Network, 45 MHz-26.5 GHz, APC3.5 .... $550.00
HP 11691D Directional Coupler, 22 dB, 2-18 GHz $450.00
HP 774D Dual Directional Coupler, 20 dB, 215-450 MHz $275.00
HP 777D Dual Directional Coupler, 20 dB, 1.9-4.1 GHz $275.00
HP 778D-011 Dual Dir. Coupler, 20 dB, ... $450.00
100-2000 MHz, APC7 test port
HP 8431A 2-4 GHz Band Pass Filter, N(m/f) $175.00
HP 8470B Crystal Detector, ... $250.00
10 MHz-18 GHz, neg. pol., APC7
HP 8472A Crystal Detector, ... $150.00
10 MHz-18 GHz, neg. pol., SMA
HP 8494B-002 Step Attenuator, ... $450.00
0-11 dB, DC-18 GHz, SMA(f/f)
HP 8494G-002 Programmable $350.00
Step Attenuator, 0-11 dB, DC-4 GHz, SMA
HP 8495G-002 Programmable $300.00
Step Attenuator, 0-70 dB, DC-4 GHz, SMA
HP 8495H-002 Programmable $400.00
Step Attenuator, 0-70 dB, DC-18 GHz, SMA
HP 8496B-002 Step Attenuator, ... $450.00
0-110 dB, DC-18 GHz, SMA(f/f)
HP 8497K-004 Programmable Step $750.00
Attenuator, 0-90 dB, DC-26.5 GHz
HP K422A WR42 Flat Broadband Detector, 18.0-26.5 GHz $350.00
HP K532A WR42 Frequency Meter, 18.0-26.5 GHz $450.00
HP K870A WR42 Slide Screw Tuner, 18.0-26.5 GHz $275.00
HP K914B WR42 Moving Load, 18.0-26.5 GHz $350.00
HP Q752D WR22 Directional Coupler, 20 dB, 33-50 GHz $650.00
HP R375A WR28 Variable Attenuator, 0-20 dB, 26.5-40 GHz $375.00
HP R532A WR28 Frequency Meter, 26.5-40 GHz $500.00
HP R752A WR28 Directional Coupler, 3 dB, 26.5-40 GHz $450.00
HP R914B WR28 Moving Load, 26.5-40 GHz $300.00
HP V365A WR15 Isolator, 25 dB, 50-75 GHz $900.00
HP V752D WR15 Directional Coupler, 20 dB, 50-75 GHz $650.00
HP X870A WR90 Slide Screw Tuner $150.00
HUGHES 45111H-2000 WR28 Isolator, 25 dB, 26.5-40 GHz $450.00
HUGHES 45712H-1000 WR22 Frequency Meter, 33-50 GHz $900.00
HUGHES 45732H-1200 WR22 Level $250.00
Set Attenuator, 0-25 dB, 33-50 GHz
HUGHES 45772H-1100 WR22 Thermistor $400.00
Mount, -20 to +10 dBm, 33-50 GHz
HUGHES 45775H-1100 WR12 .... $800.00
Thermistor Mount, -20 to +10 dBm, 60-90 GHz
HUGHES 47316H-1111 WR10 Tuneable $600.00
Detector, 75-110 GHz, positive polarity
HUGHES 47323H-1211 WR19 Flat $650.00
Broadband Detector, negative, 40-60 GHz
HUGHES 47974H-1000 WR15 SPST $375.00
PIN Switch, 250 MHz speed, 60-62 GHz response
KAY 442D Step Attenuator, 0-101 dB, 75 ohms, BNC $100.00
KRYTAR 1818 Directional Coupler, 16 dB, 2-18 GHz, SMA(f) $200.00
M/A-COM 3-19-300/10 WR19 .... $450.00
Directional Coupler, 10 dB, 40-60 GHz
MIDWEST MICROWAVE 3537 DC Block, ... $40.00
0.1-12.4 GHz, SMA(m/f) *NEW*
MINI-CIRCUITS ZFDC-20-4 .... $25.00
Directional Coupler, 19.5 dB, 1-1000 MHz, SMA(f)
MINI-CIRCUITS ZHL-42 Amplifier, ... $400.00
30 dB gain, 0.7-4.2 GHz, +28 dBm, 15V, SMA
NARDA 25171 Level Set Attenuator, ... $100.00
0-17 dB, 2-8 GHz, SMA(f)
NARDA 3000-SERIES Directional Couplers $150.00
NARDA 3024 Bi-Directional Coupler, 20 dB, 4-8 GHz $300.00
NARDA 3090-SERIES Precision High Directivity Couplers $225.00
NARDA 368NM Coaxial High Power $400.00
Load, 500 Watts, 2.0-12.4 GHz, N(m)
NARDA 369BNF High Power Termination, ... $325.00
175 Watts, 0.7-18 GHz, N(f)
NARDA 3753B Coaxial Phase Shifter, ... $1,250.00
0-55 deg./GHz, 3.5-12.4 GHz
NARDA 4000-SERIES SMA Miniature $75.00
Directional Couplers
NARDA 4245-10 Directional Coupler, ... $100.00
10 dB, 4-12 GHz, SMA(f)
NARDA 4799 Level Set Attenuator, ... $135.00
0-15 dB, 4-18 GHz, SMA(f)
NARDA 5070-SERIES Precision Reflectometer Couplers $300.00
NARDA 765-10 10 dB Attenuator, 50 Watts, DC-5 GHz, N(m/f) $135.00
NARDA 792FF Variable Attenuator, 0-20 dB, 2.0-12.4 GHz $375.00
NARDA 794FM Direct Reading Variable $375.00
Attenuator, 0-40 dB, 4-8 GHz
OMNI-SPECTRA 2085-6010-00 Crystal $50.00
Detector, 1-18 GHz, negative polarity, SMA(m/f)
PAMTECH KYG1014 WR42 Junction $250.00
Circulator, 18.0-26.5 GHz
SONOMA ENG. S-4901 WR15 Junction $125.00
Isolator, 57-59 GHz, 30 dB isolation
SONOMA ENG. S-4906 WR15 Junction Isolator, ... $125.00
60-62 GHz, 30 dB isolation
SONOMA ENG. S-4907 WR15 Junction Isolator, ... $125.00
62-64 GHz, 30 dB isolation
SONOMA SCIENTIFIC 21A3 WR42 Circulator, ... $75.00
20 dB, 20.6-24.8 GHz
SPACEK LABS DQ-1 WR22 .... $400.00
Flat Broadband Detector, 33-50 GHz
SPACEK LABS K-2X Frequency Doubler, ... $350.00
9.0-13.25 GHz in/ 18.0-26.5 GHz out
SPACEK LABS KA-3X Frequency T $350.00
ripler, 8.83-13.33 GHz in/ 26.5-40.0 GHz out
TRG B528 WR22 Direct Reading Phase $1,250.00
Shifter, 0-360 deg.,33-50 GHz
TRG V551 WR15 Frequency Meter, 50-75 GHz $600.00
TRG W551 WR10 Frequency Meter, 75-110 GHz $750.00
WAVELINE 100080 WR28 .... $200.00
Terminated Crossguide Coupler, 30 dB
WEINSCHEL 1515 Power Divider, ... $125.00
2-Way, DC-18 GHz, SMA(m/f/f)
WEINSCHEL DS109 Double Stub $150.00
Tuner, 1-13 GHz, N(m/f)
WEINSCHEL DS109LL Double Stub $150.00
Tuner, 0.2-2.0 GHz, N(m/f)

COMMUNICATIONS

HP 3762A/3763A BER Test System, 1 kHz-150 MHz $1,250.00
HP 4935A-003 Transmission Test Set, ... $1,000.00
20 Hz-110 kHz, battery power
HP 59401A HPIB Bus Analyzer $700.00
TEK 1410R NTSC Gen., w/SPG2 sync. $800.00
generator, TSG7 color bars
TEK 1411R PAL Gen.,w/SPG12 sync; $750.00
TSG11 color bars;TSG13 linearity
TEK 1411R PAL Test Gen., ... $1,000.00
w/SPG12,TSG11,TSG13,TSG15,TSG16
TEK 1411R PAL Test Gen., ... $1,100.00
w/SPG12,TSG11,TSG12,TSG13,TSG15,TSG16
TEK 1411R-opt.04 PAL Test Gen., ... $1,400.00
w/SPG12,TSG11,TSP11,TSG13,TSG15,TSG16
TEK 1420 NTSC Vectorscope $600.00
TEK 147A NTSC Test Signal Generator, with noise test signal $800.00
TEK 148 PAL Insertion Test Signal Generator $700.00
TEK 520A NTSC Vectorscope $750.00
TEK 521A PAL Vectorscope $750.00

MISCELLANEOUS

P.A.R. 5206-95,98 Two-Phase $1,500.00
Lock-in Amp., 2 Hz-100 kHz, GPIB
P.A.R. 5209 Lock-in Amp., 0.5 Hz-120 kHz, ... $2,500.00
130 dB dynamic reserve
TEK TM5006 5000-series 6-slot $600.00
Programmable Power Module
TEK TM504 500-series 4-slot Power Module $175.00
TEK TM506 500-series 6-slot Power Module $250.00
TEK TM515 500-series 5-slot Traveller Power Module $275.00

Write in 211 on Reader Service Card.

ELECTRONICS Q & A

With TJ Byers

In this column, I answer questions about all aspects of electronics, including computer hardware and software. This column doesn't replace the Tech Forum that you've grown to love and support. Instead, it will supplement it, so feel free to participate as always with your questions and answers. You can reach me on America Online at TJBYERS, on the Internet at TJBYERS@aol.com, or by snail mail at Nuts & Volts Magazine, 430 Princeland Ct., Corona, CA 91719.

What's Up:

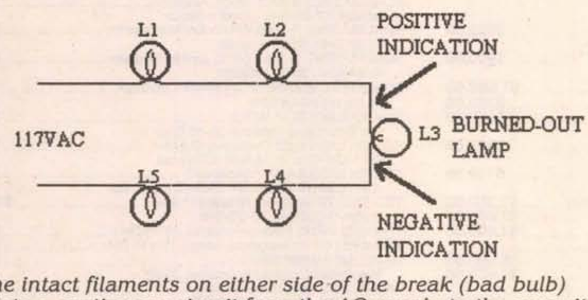
At last: Cut the Christmas burned-out bulb chase using a "magic" wand. Fun stuff: Little Nemo sleeps, simple alarm, and DTMF actuator. More serious: solar basics, MIDI interface, and a couple of power inverters (400 Hz, too). Check out the Mailbag for updates.

Bad-Bulb Locator For The Holidays

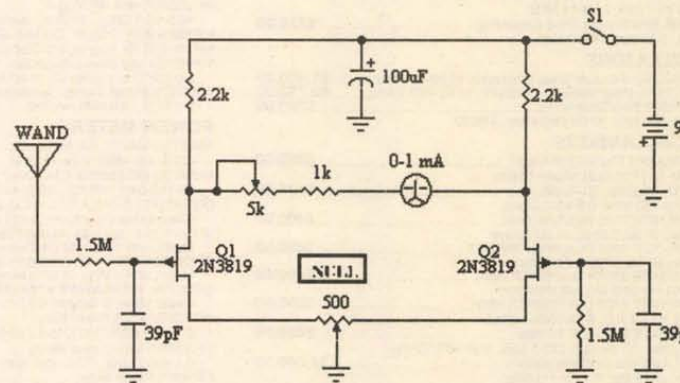
Q. I'm looking for a "Handy Tester" like the one advertised in Electronic Goldmine on page 25 of your May '98 issue. Unfortunately, they were all sold out when I called and Goldmine doesn't expect to get more any time soon. Can you guide me in finding such a "tester" somewhere else and does this device really work on Christmas light strings to find the burned-out bulb?

David L. Vrba
Dublin, CA

A. *I'm not sure what kind of sensor they used in that device, but if you're just looking for something to locate a break in an AC wire like a burned-out bulb in a Christmas light string or a bad extension cord, an electrostatic detector is just the ticket. To understand how it works, consider a string of bulbs with one burned-out bulb – an open circuit, as shown below.*



The intact filaments on either side of the break (bad bulb) complete a continuous circuit from the AC supply to the opposite sides of the broken filament. The voltage differential between wires leading to any bulb in each leg of the string is zero. However, the differential voltage across the broken filament is ground on one side and 110 VAC on the other. The presence of 110 VAC on one wire produces large electrostatic fields that are easily detected even through plastic insulation. By running an electrostatic detector (antenna) along the length of the string, the defective bulb is easily identified.



Basically, the electroscope is an adaptation of the original "transistorized" voltmeter, which uses two junction FETs in a balanced-bridge network. The gate of Q1 is connected to the antenna wire "wand" while Q2's gate goes to ground. The balance potentiometer sets the meter to mid scale and the gain control sets the sensitivity of the instrument. To use the tester, adjust the balance control for mid-scale reading while standing in the middle of the room. Now with the Christmas light string plugged into an AC outlet, move the wand near the lamp's wires. The needle will swing one way or the other, depending on whether it's closer to ground or the "high" AC side. You may have to adjust the gain control to keep the needle from pegging. Now slide the wand along the wiring string until you notice a definitive swing from one end of the scale to the other. The intervening lamp is the culprit and the burned-out bulb. Don't worry if there's more than one dead lamp in the string. Just keep up the procedure until all defective bulbs are found. Happy Holidays!

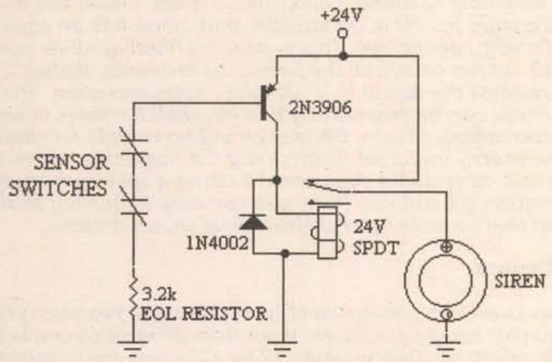
Simple Alarm

Q. I have an EOL (End Of the Line) resistor security loop that monitors the perimeter of a storage building. It hasn't been used in a while, and I need to get it up and working again. What I need is a detector that will

sound a relay-activated alarm when the loop is broken, but restore itself when the break is fixed. The EOL resistance is 3.2K and the power supply is 24 volts. What do you suggest?

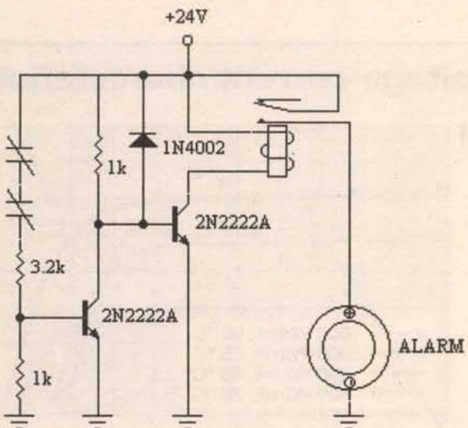
Larry
via Internet

A. *Something simple with a low part count to keep it reliable – something like this.*



The EOL resistor is used to bias the 2N3906 transistor which, in turn, actuates the relay. If the EOL link is interrupted, the relay drops out and the siren sounds. This design is more reliable than having the relay pull in to activate the alarm because it will sound off if the relay, diode, or transistor fails. If we wired it the other way around, where a break in the loop would pull in the relay, a defective transistor or relay would render the alarm worthless.

(Editor's note: Larry thanked me for the circuit, but said that what his boss really wanted is a circuit that draws no relay power until the alarm is tripped. Okay Larry, here it is.)



In this design, Q1 is turned on through the 3.2K resistor when the perimeter loop is secure which, in turn, shorts Q2's base to ground, turning it off, and prevents the relay from energizing. When the loop is broken, Q1 turns off, Q2 turns on, and the relay pulls in, sounding the alarm.

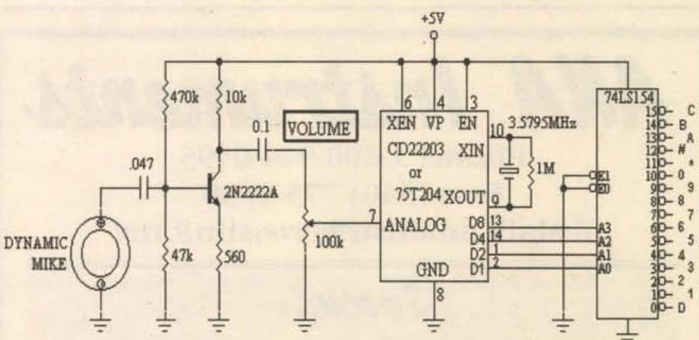
DTMF Decoder

Q. I need a circuit that will take dialing tone frequencies from a telephone earpiece using a microphone, decode the tones, then output the results as 0 through 9 logic outputs. The tones will be used to activate other devices, like room lights.

Danny Mower
Monroe, NC

A. *A couple of years ago, I would have told you to use 567 tone decoders and lots of logic gates. Today, though, it can be done a lot easier and cheaper using just two ICs and a transistor. The "brains" of this design is a DTMF (Dual Tone Multiple Frequency) receiver: a CD22204 from Harris Semiconductor or the 75T204 from Silicon Systems and TDK Semiconductors. Although the part numbers are different, the chips are identical and interchangeable. You can buy it from Newark Electronics (1-800-463-9275; http://www.newark.com) or QuestLink (http://www.questlink.com/) for about $4.00. This chip is a complete DTMF receiver that detects and decodes 16 telephone digits. Each digit is a combination of two frequencies. (Please note that the letters are for special applications and not normally used in telephone dialing.)*

Number	*Frequency #1*	*Frequency #2*
1	697 Hz	1209 Hz
2	697 Hz	1336 Hz
3	697 Hz	1477 Hz
4	770 Hz	1209 Hz
5	770 Hz	1336 Hz
6	770 Hz	1477 Hz
7	852 Hz	1209 Hz
8	852 Hz	1336 Hz
9	852 Hz	1477 Hz
0	941 Hz	1336 Hz
*	941 Hz	1209 Hz
#	941 Hz	1477 Hz
A	697 Hz	1633 Hz
B	770 Hz	1633 Hz
C	852 Hz	1633 Hz
D	941 Hz	1633 Hz



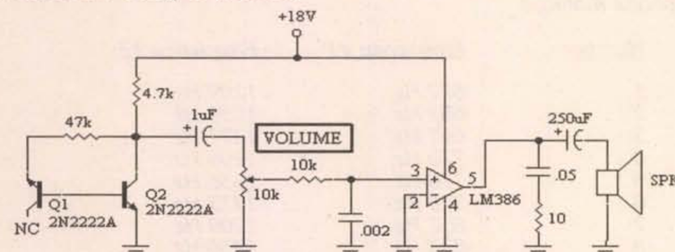
No front-end filtering is needed (the tone filters are inside the chip), and the only external component needed is an inexpensive TV colorburst crystal (3.579545 MHz) available from Radio Shack (RSU 11321437) and other sources for under $2.00. The transistor amplifies the low-level signal from the dynamic microphone to be compatible *with the receiver's analog input. The tones are analyzed and output in four-bit BCD format, which is further processed by the 74LS154 4-to-16 decoder. When a legal tone combination is detected, the corresponding pin on the 74LS154 goes low — the other pins remain high.*

Little Nemo's Slumber Secret (aka White Noise)

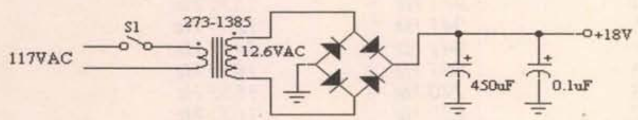
Q. I work nights and find it difficult to sleep in the daytime. I understand that there is such a thing as a white noise generator that puts out a sound that would cancel out most of the outside noise. If you know anything about this and could tell me where to find a schematic to build one, I'd really appreciate it.

Roger
Nashua, NH

A. *Over the centuries, many methods have been tried to guarantee a good night's sleep (or day, as the case may be), everything from magical potions to bewitched poison apples to Perry Como. White noise supposedly overwhelms periodic noise sources which, in turn, blocks out unwanted sounds. Whether it works for you or not remains to be seen. Here's a way to find out.*



WHITE NOISE GENERATOR



POWER SUPPLY

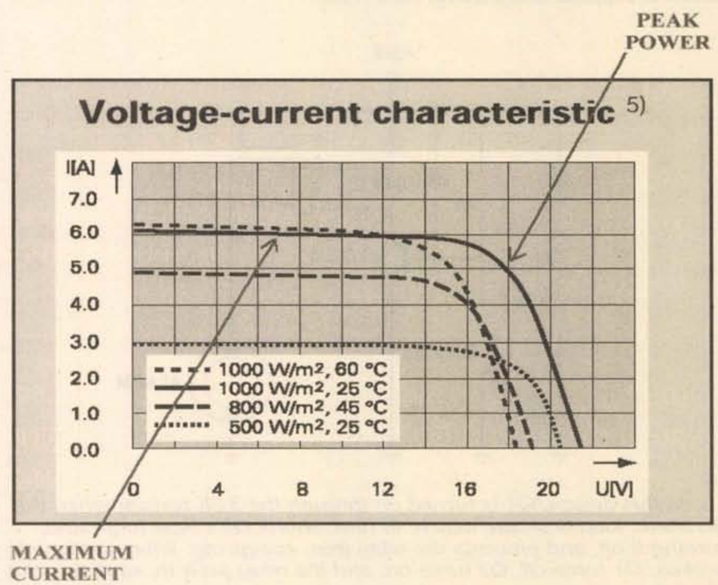
The noise is derived from a zener diode, which is made up of Q1 in the reverse-biased mode. The reversed base-emitter junction of Q1 goes into zener breakdown at about 7 to 8 volts. The zener noise is buffered by Q2 and amplified to speaker volume via the LM386 power amplifier. VOLUME controls the level of the white noise — which isn't really white noise in this design. The inclusion of the .002 uF capacitor across the input of the op amp (LM386) removes some of the high-frequency components to simulate "pink" noise, which is less harsh sounding and more soothing. Unlike white noise, which has an equal amount of energy per Hz of bandwidth, pink noise has an equal amount of energy per octave. This is done by filtering white noise with a 3 dB cut per octave as the frequency increases. Removing the capacitor restores the circuit to a full white noise spectrum. The white noise generator can be powered by two nine-volt batteries in series or the AC power supply shown. Besides providing sounds for slumber, white noise is very useful for determining the frequency response of amplifiers and other audio components. Using a spectrum analyzer or variable-frequency bandpass filter, you can map frequency peaks and valleys, but that's another story. Meanwhile, sweet dreams.

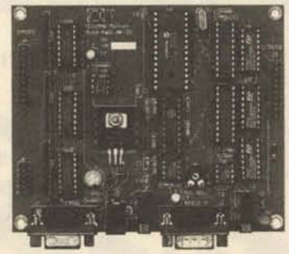
Solar Basics

Q. I recently came into possession of (okay, I bought) two solar panels. They are surplus bought at different times from different places, but appear to be identical. They measure 12 by 12 inches and generate about 13.5 volts in full sun. My question is, how do I determine the amperage of the panels (neither has markings)? I'd like to use the panels to trickle charge a battery using the small load controller/charger you detailed in your "Solar Workshop" column a while back, but I don't know if it can be done.

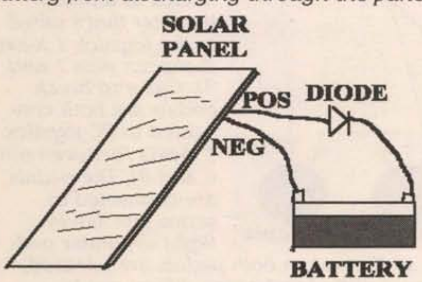
Andrew L. Ayers
via Internet

A. *A solar panel is a current source, not a voltage source, as you can see below.*





Simply place an ammeter or DMM across the panel and see how much current it outputs. Given your specs, each panel should generate about 1/2 amp, which is plenty enough to trickle charge a 12-volt marine or car battery. In fact, the current is low enough that you don't need the controller. Simply wire the two panels in parallel and connect them to the battery. A charge controller isn't needed until the charging current exceeds one-tenth (C/10) the capacity of the battery, about six amps for a typical marine battery. The diode prevents the battery from discharging through the panel at night.



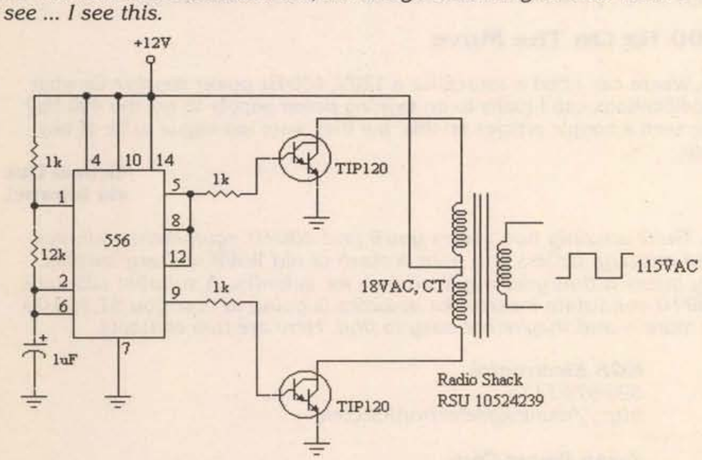
(Editor's note: Mr. Ayers got back to me, and said one panel measured 0.5 amps and the other measured 0.1 amps, which again proves that you can't judge a book by its cover.)

Lightweight Power Inverter

Q. I'm looking for a small 12-volt DC to 115-volt AC inverter that I can use to power an electric razor or clock radio from my car's cigar lighter. The commercial units start at about 150 watts and are overkill for what I want. Does your magic crystal ball have what I want?

T. Gifford
via Internet

A. *Let me have a look see. Yes, the image is starting to clear now. I see ... I see this.*



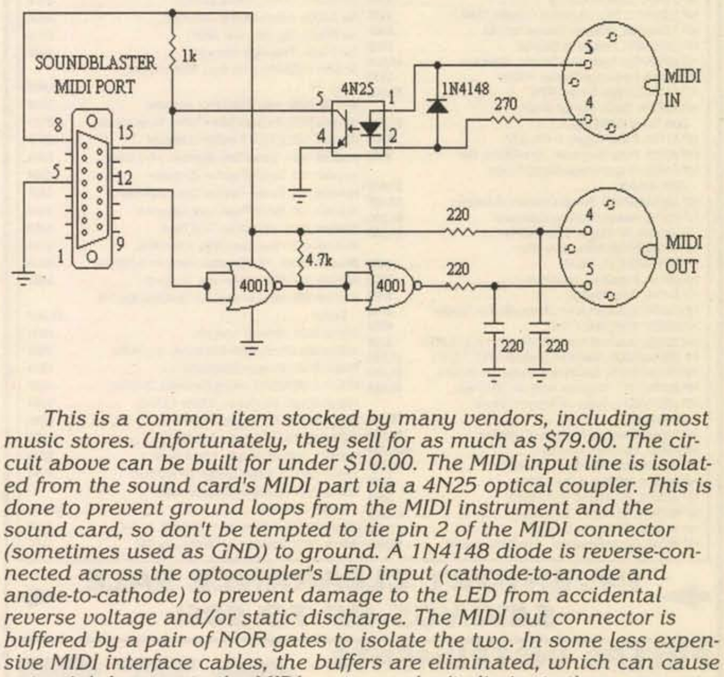
This low-power inverter turns 10 to 16 volts into 60-Hz, 115-volts squarewave power-to-power razors and the like up to 25 watts. The 556 contains two 555 timers, one of which is wired as the master clock that oscillates at 60 Hz. The other is used as an inverter. The complimentary outputs (pins 5 and 9) are used to drive the TIP120 transistors in a push-pull mode. When pin 5 is high, pin 9 is low; when pin 5 is low, pin 9 is high. This causes the driver transistors to alternate conduction times, which forces the transformer to reverse magnetic polarity as they go back and forth. The output winding delivers an alternating squarewave of 115 VAC.

MIDI Cable

Q. Can you give me the wiring diagram for the MIDI cable that connects to a sound card? And if you know the diagram for steering and foot pedal controls that connect to a joystick port, that would be helpful, too.

Raymond N. Simmons
via Internet

A. *The 15-pin joystick port on your sound card doubles as a MIDI port that allows you to communicate with external MIDI devices. For example, you could connect a Yamaha keyboard to your computer via this port and sequence your music on the PC. To do this, though, you need a MIDI adapter, like the one shown below.*



This is a common item stocked by many vendors, including most music stores. Unfortunately, they sell for as much as $79.00. The circuit above can be built for under $10.00. The MIDI input line is isolated from the sound card's MIDI part via a 4N25 optical coupler. This is done to prevent ground loops from the MIDI instrument and the sound card, so don't be tempted to tie pin 2 of the MIDI connector (sometimes used as GND) to ground. A 1N4148 diode is reverse-connected across the optocoupler's LED input (cathode-to-anode and anode-to-cathode) to prevent damage to the LED from accidental reverse voltage and/or static discharge. The MIDI out connector is buffered by a pair of NOR gates to isolate the two. In some less expensive MIDI interface cables, the buffers are eliminated, which can cause potential damage to the MIDI port – so don't eliminate them, no matter how tempting! Here are pinouts of the SoundBlaster's game port *connector and five-pin MIDI connectors.*

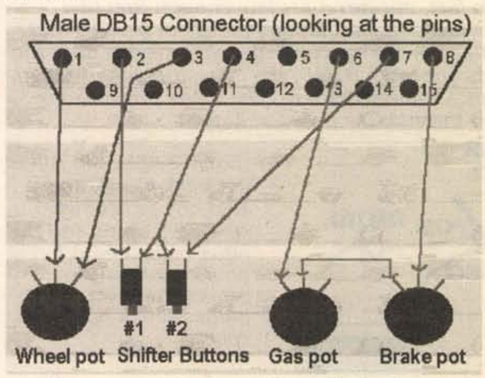
Sound Blaster MIDI/Game Connector

Pin	*Function*
1	*+5V*
2	*X button for joystick A*
3	*X potentiometer for joystick A*
4	*GND*
5	*GND*
6	*Y potentiometer for joystick A*
7	*Y button for joystick A*
8	*+5V*
9	*+5V*
10	*X button for joystick B*
11	*X potentiometer for joystick B*
12	*MIDI out*
13	*Y potentiometer for joystick B*
14	*Y button for joystick B*
15	*MIDI in*

MIDI 5-pin DIN Connector

Pin	*MIDI in*	*MIDI out*
1	*N/C*	*N/C*
2	*N/C*	*GND*
3	*N/C*	*N/C*
4	*Current source (+)*	*Current sink (-)*
5	*Current sink (-)*	*Current source (+)*

Now for the second part of your question: Interfacing the joystick to the sound card's MIDI/joystick port. You specifically asked for steering and foot pedal controls, which are often used in car games. Okay, here it is.



The steering wheel, which can be cannibalized from a kid's toy car, is connected to a potentiometer that's wired to the joystick 1 X-axis (between pins 1 and 3). Gas and break pedals are both connected to PC joystick 1 Y-axis (between pins 6 and 8). The pedals are connected in series just like in flight simulator pedals. The connection is made so that when both pedals are released, the joystick interface sees about 50K of resistance. When gas is pressed (and break is kept up) the resistance increases. When the break pedal is fully pressed and gas pedal is released, the pedal's system gets the minimum resistance. This prevents you from accelerating when both the brake and gas pedals are to the metal. The shift buttons are standard PC joystick 1 buttons. For more detailed wiring diagram of steering wheels and pedals, check "Build Your Own Wheel & Pedals" article from Wally's World (http://www.oz.net/~wottenad), "How To Build Rudder Pedals (for little money)" from http://me ritbbs.unimaas.nl/Fun/pedals/pedals.htm, and Lew's Wheels Web page (http://www.monmouth.com/~lw4750/index.html).

400 Hz On The Move

Q. Where can I find a source for a 120V, 400-Hz power supply? Or what modifications can I make to an existing power supply to get the 400 Hz? I've seen a couple articles on this, but they were too vague to be of any help.

Michael Duc
via Internet

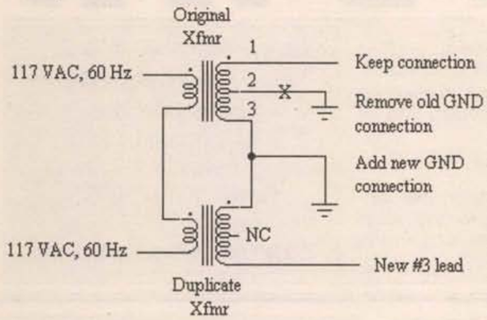
A. *There are only two places you'll find 400-Hz equipment: avionics and military. Unless you have a stash of old WWII military surplus, my guess is that your application is for avionics. A suitable 125-watt, 400-Hz solid-state inverter for avionics is going to cost you $1,300.00 or more – and they're not easy to find. Here are two contacts.*

KGS Electronics
626-574-1175
http://www.kgselectronics.com

Zzzap Power Corp.
514-369-4919
http://www.zzzap.com

If the power source isn't too critical, in that it can tolerate a squarewave input instead of pure sine, the circuit in the "Lightweight Power Inverter" circuit above can be modified for 400Hz operation. Simply change the value of the 1 uF capacitor to 0.15 uF. You can use the same transformer. While the frequency won't be spot on, it should be close enough for all but the most critical applications. Furthermore, you can fine tune the frequency by adjusting the value of the 12K resistor up or down.

If you're trying to power surplus old 400-Hz WWII equipment from 60 Hz, here's a trick we used back in the "old" days.



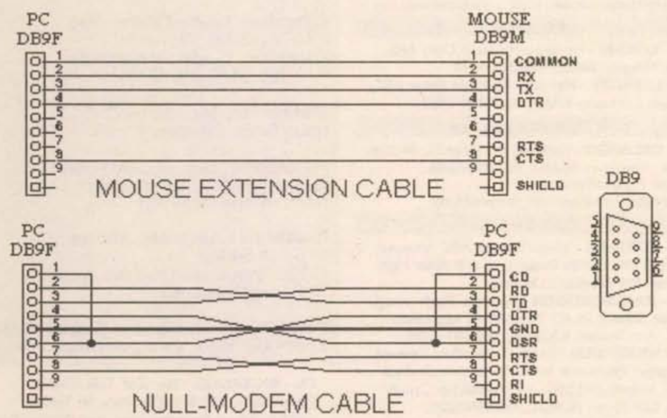
Wire two 400-Hz power transformers in series, as shown, and run them from 60 Hz. The benefit of 400-Hz line operation is that the transformers use smaller iron cores – a definite weight advantage for avionics and soldiers on the march. The problem is that when you try to run these transformers off 60 Hz, they get VERY hot! By wiring two 400-Hz power transformers in series, you reduce the voltage across each by half and double the iron content. Ta-da! A working solution. The catch is you need two identical power transformers, which we used to steal from a "dead" relative of the same, and you need to find a place to mount the new transformer in the surplus device. Multiple-secondary transformers need to have this modification made for each winding. Alternatively, you might be able to find an affordable military surplus 400 Hz dynamo (motor generator) from http://www.surplustuff.com /misc.html.

Not A Dumb Mouse, A Null Modem

Q. I need to add an extension to my mouse. I've tried two different extension cords, and neither works. All I got is a message saying "mouse not installed." What's up?

Anonymous
via Internet

A. *Even though there are many different mouse protocols and different connectors, the extension should work if it's a pass-through cable.*



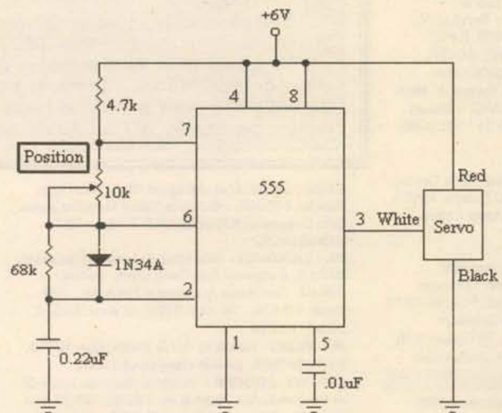
In essence, if pin 1 of the input goes to pin 1 of the output and pin 2 goes to pin 2, nothing changes. What I suspect is that you have a nine-pin mouse connector (DB9) that you're trying to extend using a conversion cable, like a null modem. In a null-modem cable, at least two of the wires are reversed, as shown above. Null-modem cables are plentiful and sell for about $5.00, which is probably what you thought was an extension cable. What's a null modem cable, you ask? It lets you connect one PC to another PC using regular communications software without going through POTS (plain old telephone system) wires. Think of it as a one-on-one local area network (LAN). Extension cables (which are clearly labeled as such) are plentiful and cheap, too, but building your own has its merits. Using a couple of DPDT switches, you can even make a universal extension/null-modem cable as one. Think about it. Quiz on Monday.

Servo Controllers ... Again

Q. I was wondering if I could ask you about the "Simpler Servo Controller" in the Oct. '97 issue? I've constructed this circuit several times, and tried it with a variety of servos. Although the servo hums (indicating a pulse is coming through), it doesn't move, and after a short while the 555 heats up. I'm using a regulated five-volt power supply to drive the circuit. Do you know if this circuit actually works? I've seen other circuits on the Web that claim to control servos, but only vary frequency, not pulse width. I have managed to control servos using circuits I've found on the Internet, but they only provide about 45 degrees of rotation. There has GOT to be a simple servo controller circuit out there that works! Any idea where I can get one? I've been searching like mad.

Walt Noon
via Internet

A. *I never built the circuit that the reader submitted in the Reader's Tip section of that issue, but it should work. You might want to play with the values of the 39K and 220K resistor to fine tune the response timing. Meanwhile, here's a circuit that I have built and tested – and it works.*



The pulse width varies between 1 ms and 2 ms for the left and right extremes, which can span anywhere from 160 degrees to 270 degrees, depending on the servo; a 1.5 ms pulse centers the sweep. The width of the pulse is adjusted by the 10K Position potentiometer. This pulse repeats every 20ms, for a repetition rate of about 50 Hz (servos typically operate between 20 Hz and 80 Hz). The 1N34A is a pulse-shaping diode that sharpens the fall time. The red and black servo leads are power, and the white lead from the servo is the control lead. Have fun!

MAILBAG

Dear TJ Byers:

About the LM558 timer IC in the Sept. '98 column, this chip may be "long obsolete" but there are many uses for this timer. It's available through **Tech America (1-800-877-0072; http://www.techam.com)** for just $0.87. You can find typical applications for this chip in the *Radio Shack Engineer's Notebook II* on pages 102 and 103. I hope Phil Clock and other experimenters can use this information.

Raymond Sylvester
North Branford, CT

Response:

Yes, rumors about the death of this chip are premature. ***Philips Semiconductor (1-800-234-7381; http://www.semiconductors .philips.com)*** *still makes them under the name NE558N. You can download the NE558 data sheet from* ***QuestLink (http://www.questlink.com)*** *and order the part from their Engineer's SuperStore on the Web site.*

TJ Byers
Q & A Editor

Dear TJ:

After reading your answer to "Ring Me Up Sometime" I thought that you might like a possible answer to the secret number for calling oneself back. In our area, northern California, we simply call our own seven-digit phone number and get a busy signal. We then hang up and about five seconds later the phone company rings us back. We use this method as an intercom and I believe it's free. Our phone repair person freely told us about this method, and I believe you can call a phone representative and get the same answer if you just ask.

Chris
Bieber, CA

Response:

I've received several letters like this from across the country, and I'm sure it works for many locations. It certainly worked when I lived in southern California. However, it won't work if you have voice mail or call waiting. I now live in northern California, but when I called my local representative (Pac Bell) and repair service (611) about a call-back service before answering the reader's question, they denied its existence. Fortunately, my Telecom repair lady (cable, not Pac Bell) knew the number and was more than willing to spread the word. So much for a kinder, gentler phone company.

TJ Byers
Q & A Editor

Events CALENDAR

The Events Calendar is a free service for publicizing electronic events such as amateur radio hamfests, flea markets, etc. If your organization is sponsoring an event and would like a free listing, contact us at least 60 days in advance. Include your flyer, estimated attendance, name of the person to contact, and phone number.

Complimentary issues are available upon request for distribution to your attendees. A street address for UPS is required.

While we strive for accuracy in our calendar, we can not be responsible for errors or cancellations. The information contained in this column is for the use of the readers of *Nuts & Volts* and may not be republished in any form without the written permission of T & L Publications, Inc.

All listing information should be sent to:
Nuts & Volts Magazine
Events Calendar
430 Princeland Court
Corona, CA 91719
Phone 909-371-8497
Fax 909-371-3052
E-mail events@nutsvolts.com

DECEMBER 1998

DECEMBER 5

AL - DOTHAN - Hamfest. Wiregrass ARC, Cheryl Tucker KD4BWE, 334-677-7485

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - OKEECHOBEE - Hamfest. Okeechobee ARC, Al Berryman AD4RZ, 941-467-0516. E-Mail: ad4rz@juno.com

GA - CLAXTON - Hamfest. Veterans Community Center, Hwy. 280 W. VE Exams. Talk-in: 147.075+. Claxton AR Emergency Service, Mr. Ellie Waters WB4CJB, 912-653-4939. E-Mail: ellie@premierweb.net. Wes Kennedy KU4SR, 912-739-2047, E-Mail: ku4sr@mci2000.com

IL - JACKSONVILLE - Hamfest. Turner Jr. High School. VE Exams. Jacksonville ARS & Illinois Valley ARC, Tim Childers KB9FBI 217-245-2061. E-Mail: kb9fbi@fgi.net
Web: http://www.qsl.net/k9jx

LA - MINDEN - Christmas Hamfest. Civic Center, 520 Broadway. 8:30am-3pm. VEC Exams. MARA repeater 147.300+. MARA, Inc., Dusty Collins KB5WFE, 318-371-0636.
E-Mail: dustyc@prysm.net
Web: http://www.norwesla.com/mara.htm

MN - GOLDEN VALLEY - Hamfest. Courage Handi-Ham System, Nancy Meydell, 612-520-0512

NC - GREENSBORO - Hamfest. Coliseum Special Events Center. 9am-3pm. 76 Group, 336-851-1676. http://www.sabwc.com/gsohamfest

DECEMBER 6

CA - LIVERMORE - Hamfest. Livermore ARK, Cliff Kibbe KF6EII, 209-835-6715.
E-Mail: larkswap@hotmail.com

DECEMBER 12

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

FL - LAKE CITY - Hamfest & Computer Show. Columbia County Fairgrounds, SR 247, Gateway to FL #4. Columbia ARS, Joe Aymond WD4EOJ, 904-935-2405 6-10pm, E-Mail: wd4eoj@isgroup.net or Colin Boutwell WA5RKR, 904-755-7960, E-Mail: wa5rkr@isgroup.net

SC - UNION - Hamfest. National Guard Armory, Industrial Park Rd. 8am-2pm. Talk-in: 145.250-. Union County ARC, Roger Gregory KI4RG, 864-427-1462. E-Mail: rgregory@carol.net

DECEMBER 19

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

JANUARY 1999

JANUARY 2

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

TN - MORRISTOWN - Hamfest & Computer Show. Talley Ward Recreation Bldg. Talk-in: 147.303+ & 53.030-. Lakeway ARC, Perry Hensley N4PH, 423-828-4848 E-Mail: n4ph@juno.com. Kemp Lawson KF4AGB, 423-587-3320.
E-Mail: kemplawson@aol.com.
Web: www.usit.net/mfawbush/larc.html

JANUARY 9

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

CO - LOVELAND - Superfest. Larimer County Fairgrounds, 700 Railroad Ave. 9am-3pm. VE Exams. Talk-in: 145.115- or 146.85-. Northern CO ARC, 970-352-5304

NY - MARATHON - Hamfest. Skyline ARC, Patrick Dunn KC2BQZ, 315-468-5909

SC - GREENWOOD - Hamfest & Computer Show. Greenwood Civic Center, 1610 Hwy. 72 E. 9am-5pm. FCC exams. Talk-in: 147.165+ (open) alternate: 146.52 simplex. Greenwood ARS, Frank Kolar WA9FWO, 864-229-5639.
Web: http://www.w4gwd.org

WI - WAUKESHA - Hamfest. Waukesha County Expo Center Forum. 8am-2pm. West Allis RAC, Phil Gural W9NAW, 414-425-3649

JANUARY 9-10

FL - FT. MYERS - Hamfest. Sat: 9am-3pm, Sun: 9am-2pm. Talk-in: 146.880. Ft. Meyers ARC, Colleen Sammons KQ4TR, 941-936-1431.
E-Mail: csammons@juno.com

JANUARY 10

IN - SOUTH BEND - Hamfest. The Century Center, US 33 N. at Jefferson Blvd. 8am-3pm. Talk-in: 145.290-. Michiana Valley Hamfest Assn., Bob Denniston KA9WNR, M-F 7-10pm EST. 219-291-0252

FL - LANTANA - Flea Market. Next to Pizza Hut, 6170 S. Congress Ave. 7am-12pm. Talk-in: 146.67. The Major Armstrong FM Assn., Jeff Beals WA4AW, 561-586-5120. Al West W4SDC, 561-641-8244

MI - FLINT - Hamfest. AR & Youth, Clay KF8UI, 810-233-7889. E-Mail: clay@iavbbs.com

MO - ST. JOSEPH - Hamfest. Ramada Inn, I-29 @ Frederick Ave. 8am-3pm. Talk-in: 146.85 and 444.925. Missouri Valley ARC & Ray Clay ARC, John Winkler WB0VRA, 816-424-6484. Gaylen Pearson, E-Mail: WB0W@IBM.Net

JANUARY 16

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

LA - HAMMOND - Hamfest. Southeast Louisiana ARC, Jack Stang N5XVJ, 504-542-7605.
E-Mail: jstang@i-55.com

JANUARY 17

MI - HAZEL PARK - Hamfest. Hazel Park High School, 23400 Hughes St. 8am-2pm. Talk-in: 146.64 (-). Hazel Park ARC, Tom Austin N8TMQ, Tom Krausnick WC9F. HPARC, POB 368, Hazel Park, MI 48030.

NY - YONKERS - Flea Market. Lincoln High School, Kneeland Ave. 9am-3pm. VE Exams. Talk-in: 440.425 PL 156.7, 223.760 PL 67.0, 146.910, 443.350 PL 156.7. Metro 70cm Network, Otto Supliski WB2SLQ, 914-969-1053

OH - NELSONVILLE - Hamfest. Sunday Creek AR Federation, Russ Ellis N8MWK, 740-767-2226

VA - RICHMOND - Hamfest. The Showplace, 3000 Mechanicsville Tpke. 8:30am-3:30pm. Talk-in: 146.88 repeater. RATS, Jim Clark N3JJF, 804-739-2269 ext. 3378. Web: http://frostfest.rats.net

JANUARY 23

NC - WINSTON-SALEM - FirstFest. Dixie Classic Fairgrounds, Home & Garden Bldg. 8am-1pm. Talk-in: 146.64 MHz. Forsyth ARC, Inc., Tom Gallagher N4IOZ, 336-723-7388. E-Mail: n4ioz@ibm.net Web: http://www.rbdc.com/~kq4lo/farc.htm Web: http://members.xoom.com/w4nc/

TN - GALLATIN - Hamfest. Civic Center, off Hwy. 31E. 8am-2pm. VE Exams. Talk-in: 147.90/.30 tone 114.8. Tennessee Valley AR Network, Bill Ferrell N4SSB, 615-451-5992

JANUARY 24

IL - VILLA PARK - Hamfest. Odeum Expo Center. 8am-2pm. VE Exams. Talk-in: 145.390-. Wheaton Comm. RAs, Donald Motz N9NYX, 630-665-7757. E-Mail: donlin@xnet.com http://www.w9ccu.org

OH - DOVER - Hamfest. Tusco ARC, Howard Blind KD8KF, 330-364-5258

JANUARY 29-30

MS - JACKSON - Hamfest. Jackson ARC, Ron Brown AB5WF, 601-956-1448 or 601-982-0101.
E-Mail: ab5wf@juno.com
Web: http://www.jxnarc.org

JANUARY 30

AL - GREENVILLE - Hamfest. Butler & Pike County RACES, Jerry McCullough KE4ERO, 334-382-7644. E-Mail: w4mpq@alaweb.com

MO - NEVADA - Hamfest. Nevada ARC, Dennis Kimrey. E-Mail: dkimrey@ipa.net
E-Mail: k0cb@ipa.net
Web: http://www.users2.ipa.net/~dkimrey

JANUARY 31

CA - SANTA ANA - Swapmeet. ACP parking lot. Mary Russo 714-558-8813

MD - ODENTON - Hamfest. Maryland Mobileers ARC, Bill Ziegler KA6TYY, 410-987-2384.
E-Mail: ka6tyy@juno.com

FEBRUARY 1999

FEBRUARY 6

AR - WEST MEMPHIS - Hamfest. Dixie AR Group, Kellye Farris KB5RCE, 870-732-8724. E-Mail: kb5rce@media-two.com
Web: http://www.media-two.com/DARG

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

SC - NORTH CHARLESTON - Hamfest. Stall High School. 8:30am-4pm.VE Exams. Charleston ARS, Jenny Myers WA4NGV, 843-747-2324. E-Mail: brycemyers@aol.com

FEBRUARY 6-7

FL - MIAMI - Tropical Hamboree. Fair Expo Center, S.W. 112th Ave. & Coral Way. VE Exams. Talk-in: 146.925, 146.76, 444.525. Dade Radio Club of Miami, Evelyn Gauzens. 305-642-4139, E-Mail: edg@elink.net. 305-226-5346, E-Mail: wd4sfg@bellsouth.net. Web: www.hamboree.org

FEBRUARY 7

OH - LORAIN - Hamfest. Northern Ohio ARS, Mike Willemin W8EU, 440-324-4574

PA - LATROBE - Hamfest. Chestnut Ridge ARC, William Demosky K3AFS, 724-539-1552

FEBRUARY 12-13-14

FL - ORLANDO - Hamfest. Northern FL Section Conv., Tim Starr AE4NJ, 407-850-9258.
E-Mail: AE4NJ@aol.com
Web: http://www.oarc.org/hamcat.html

FEBRUARY 13

CA - FONTANA - Inland Empire ARC Amateur Radio & Electronics Swapmeet. A B Miller High School. Bill 909-822-4138 eves

MA - MARLBOROUGH - Hamfest. Marlborough Middle School, Rt. 85. 10am-2pm. Algonquin ARC, Ann Weldon KA1PON, 508-481-4988

NY - WESTFIELD - Hamfest. Westfield Exempt Volunteer Fireman's Assn., 75 Bourne St. 8am-3pm. Talk-in: 145.150 (-). Chautauqua County RAs, Eric Kroon N2PCQ, 716-595-3220.
E-Mail: ekroon@netsync.net

FEBRUARY 14

OH - MANSFIELD - Mid*Winter Hamfest & Computer Show. Richland County Fairgrounds. Talk-in: call W8WE on 146.34/94. InterCity ARC, Inc., Pat Ackerman N8YOB, 419-589-7133 after 2pm EST.

FEBRUARY 20

AR - RUSSELLVILLE - Hamfest. AR River Valley AR Foundation, Margaret Alexander KC5MCS, 501-968-7270. E-Mail: ealexand@cswnet.com

CA - SANTEE - ARC of El Cajon Ham, Computer & Electronic Swapmeet. Santee Drive-in. 619-561-0052

FL - BROOKSVILLE - Hamfest. Spring Hill VFW Post 10209, Spring Hill Dr. between US 41 & Mariner Blvd. Talk-in: 146.715. Hernando County ARA, Ralph Wilson AF4FC, 352-754-9653. Jim Angello KE4SZP, 352-688-5214.
E-Mail: jangello@fiber-net.com
Web: www.fiber-net.com/pub/hcara/index.htm

MN - BLAINE - Hamfest. Robbinsdale ARC, Jerry Dorf N0FWG, or Harriet Johanson 612-537-1722. E-Mail: jerryd@skypoint.com

OR - RICKREALL - Hamfest. Polk County Fairgrounds, 520 S. Pacific Hwy. W. Talk-in: 146.86-. Salem Repeater Assn. and Oregon Coast Emergency Repeater, Evan Burroughs N7IFJ, 503-585-5924 before 8pm.
E-Mail: n7ifj@teleport.com
Web: http://sra.goldcom.com/sraflyer.htm

FEBRUARY 21

MI - FARMINGTON HILLS - Swap 'n Shop. William M. Costick Activities Center, 28600 Eleven Mile Rd. 8am-3pm. Talk-in: 145.350-repeater and 146.52 simplex. Livonia ARCs, 734-261-5486. E-Mail: swap@larc.mi.org
Web: www.larc.mi.org

NC - ELKIN - Hamfest. Briarpatch & Foothills ARCs, Jimmy Holbrook KB4GKI, 336-957-3820. E-Mail: kb4gki@aol.com Web: http://members.aol.com/kb4ghi/kb4gki.html

FEBRUARY 27

KY - CAVE CITY - Hamfest. Mammoth Cave ARC, 502-651-2363. E-Mail: lbrumett@glasgow-ky.com Web: http://www.scrtc.blue.net/mcarc

VT - MILTON - Convention. RAs of Northern VT, Mitch Stern W1SJ, 802-879-6589. E-Mail: w1sj@vbimail.champlain.edu Web: http://www.ranv.together.com


HAPPY HOLIDAYS
TO ALL

ELECTRONIC CIRCUIT SYMBOLS & NOTATIONS

.by Ray Marston

Ray Marston looks at some controversial aspects of modern circuit symbology in this special feature article.

INTRODUCTION

Back in May '97, I started writing regular 'circuit application' feature articles for *Nuts & Volts* magazine. All of these articles are specifically aimed at experienced design engineers and competent electronics enthusiasts (rather than at novices or complete beginners), and are unusual in two special respects.

They are unusual, first, because most of them carry (on average) about 20 illustrations or practical circuit diagrams, and second, because all of the circuit diagrams use International style — rather than US Customary — circuit symbols and component notations.

All of these articles have been well received by most *Nuts & Volts* fans, but some readers (who admit to being electronics novices) have complained that they are quite bemused by the component notations that I use in these articles. I suspect that quite a few other *Nuts & Volts* fans may feel the same way so, in this special article, I aim to explain the operation of the International style electronic circuit diagram system, and to explain the system's advantages over the US Customary system. This is a fairly controversial subject and may annoy some readers, so I will start off by presenting my qualifications for writing about it, as follows:

MY QUALIFICATIONS

I have been an electronics design engineer and writer/author for over 30 years. During that period, I have — amongst other things — been editor or technical editor of four different electronics magazines, have written about 2,000 technical articles, and have written 31 electronics engineering books. Many of my magazine articles are published internationally, and — in various periods — have appeared regularly in magazines in the UK, Germany, Holland, Australia, Canada and the USA.

Of my 31 books, two were first published in Germany, and the rest in the UK; several were later published in the USA. Between them, these books have been translated into about a dozen different languages (often with suitably modified circuit diagrams), including Russian, Hindustani, and most major European tongues.

Throughout the past five years, I have produced most of the artwork and circuit diagrams that accompany my books and magazine articles (including those used in *Nuts & Volts*), using a *Corel DRAW 3* artwork/CAD package and my private symbols library. I generate an average of about 350 diagrams a year, and have thus produced about 1,750 technical illustrations and diagrams in the past five years.

As a consequence of all the above, I have lots of professional experience in the technical publishing business and in generating modern circuit diagrams, and am familiar with many of the different electronic circuit symbol and notation systems that are used in various parts of the world and with their specific advantages and disadvantages compared to other systems.

TYPICAL CIRCUIT DIAGRAMS

In the western world, most major industrial countries have their own individual preferred styles for electronic circuit symbols and notations, but these styles are not too rigidly applied and often vary considerably between one technical publisher and another, according to the 'house style' of the individual publishing company. In the USA, for example, the so-called 'US Customary' system is normally used, but the precise details of the system vary significantly between different electronics magazines.

Figures 1 to *5* show examples of how exactly the same circuit diagram can vary when published by particular electronics magazines in particular parts of the western world. The circuit is that of a simple LM386 audio power amplifier, with its voltage gain set at x200 by C4 and with its output protected by the C3-R1 Zobel network and loaded by an eight-ohm speaker.

Figure 1 shows the diagram drawn using the familiar US Customary system, using the basic house style of *Electronics Now* magazine, and *Figure 2* shows the same diagram drawn in the house style of the German electronics magazine *Elrad*, which uses a simple rectangular symbol (rather than a zig-zag) to represent a resistor.

Regarding the German capacitor symbols, the two parallel lines used to represent C1 and C3 indicate that these are ordinary non-electrolytic components, and the black and white rectangles used to represent C2 and C4 indicate that these are electrolytic capacitors; the '+' signs associated with C2 and C4 indicate that the capacitors are polarized types, and that the white terminal is positive.

In the UK, British electronics

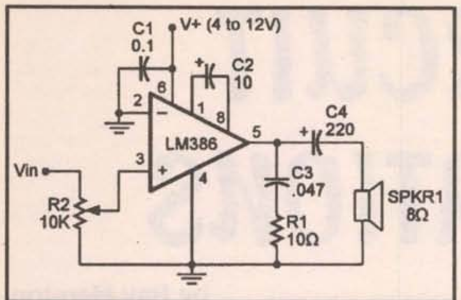


Figure 1. Circuit in the house style of *Electronics Now* magazine (USA).

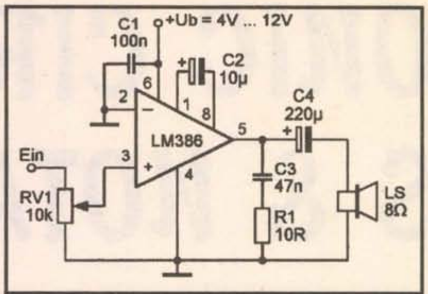


Figure 2. Circuit in the house style of *Elrad* magazine (Germany).

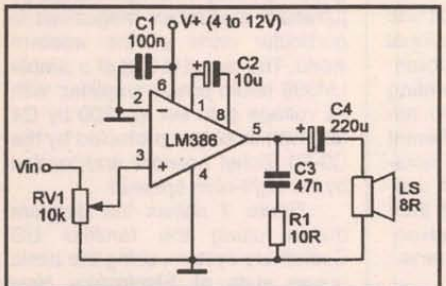


Figure 3. Circuit in the house style of *Electronics Today International* magazine (UK).

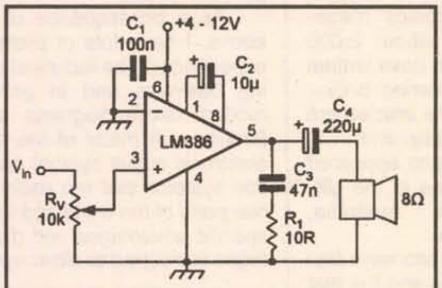


Figure 4. Circuit in the house style of *Electronics World* magazine (UK).

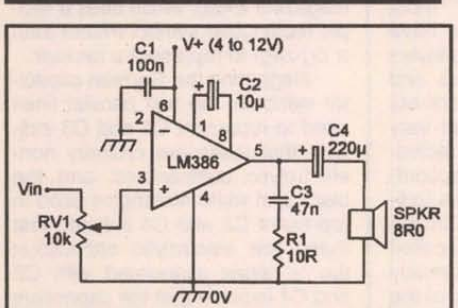


Figure 5. Circuit drawn in typical International style.

magazine sales are dominated by six popular titles. Half of these use the zig-zag resistor symbol in their circuit diagrams, and half use the simple rectangular symbol. *Figure 3* shows the *Figure 1* diagram redrawn in the house style of one of the most popular British electronics magazines, *Electronics Today International*, which uses the simple rectangle to represent a resistor, and uses two black rectangles to represent an ordinary non-electrolytic capacitor.

The most prestigious British electronics magazine is *Electronics World*, which is aimed directly at professional engineers and managers; it has its own basic house style for circuit diagrams, but varies the style slightly from article to article. *Figure 4* shows *Figure 1* redrawn in this magazine's basic house style; note the awkward mixture of upper-case and subscript characters used to denote component numbers, etc.

Finally, *Figure 5* shows *Figure 1* drawn in my own particular version of the International circuit diagram style (which I use in my *Nuts & Volts* articles), in which resistors are drawn as zig-zags, capacitors are in simplified European style, and component values are given in formal 'International' style, which is explained in a later major section of this article.

Note in *Figures 1* to *5* that all five basic diagrams are quite easy to understand, in spite of the variations in the styles of the symbols used to represent resistors, capacitors, ground points, and loudspeakers. Also note that the variable resistor is notated by RV (Resistor, Variable) in the four non-US diagrams, but by a simple R in *Figure 1*. Finally, note that the *Figure 2* to *5* diagrams use a plain R instead of the symbol to indicate a resistor's value in ohms, and (in *Figures 2* and *4*) use the symbol only to indicate the loudspeaker's nominal *impedance* value.

The easily-understood *Figure 1* to *5* circuits are analog designs. Foreign digital designs can be far harder to understand. *Figure 6*, for example, shows some of the crazy official symbols used to represent simple logic gates in Europe. In practice, most European electronics book and magazine publishers sensibly adhere to the American MIL/ANSI symbol system, which is also used in the normal 'International' diagram system.

For most American readers, the only problems presented by the non-US *Figure 2* to *5* diagrams relate to the International component value notation systems that they use, which all notate the 10 resistor as 10R, and notate 0.047µF capacitor C3 as 47n (the odd 220u — rather than 220µ — notation used on C4 in *Figure 3* is simply a house style peculiarity used by one UK magazine). Before explaining how the International notation system works, I will explain *why* it was developed.

EVOLUTION OF THE 'INTERNATIONAL' SYSTEM

Prior to the mid 1970s, the electronic component notation systems used by most European countries were similar to the present US Customary system and were loosely based on the metric scientific notation system that — in 1960 — became officially known as SI (Système Internationale d'Unités).

In the 1960s, however, major developments in the semiconductor industry resulted in a great increase in the complexity of practical circuit designs, and industry and commerce began looking for ways of producing the resultingly complex circuit diagrams and literature with greater efficiency.

Matters reached a historic peak in 1975 when the British Standards Institute (BSI) published — after a very long period of study and consultation — a list of recommendations concerning this subject.

Many of the 1975 BSI recommendations — particularly those relating to the use of new digital circuit symbols — were pretty stupid, and were rejected by most of the electronics industry, but those relating to an international system of electronic component-value notation were excellent, and were soon adopted by most of the world's industrial nations, with the notable exception of the USA.

This new notation system was, in effect, an improved and streamlined version of the existing SI-based system, and was thus quite easy to learn. When its basic form was first specified, it was required to be designed as a simple easily-printed code that indicates an electronic component's value clearly, briefly, without ambiguity, and with a minimum loss of clarity if poorly printed.

This last requirement immediately ruled out the use of decimal points in the new code system, and the requirement for brevity called for (1) the elimination of all superfluous information from the code, and (2) for sensible compression of the remaining data.

Regarding point (1) in the 'brevity' requirement, note that in circuit diagrams, when indicating the value of a symbolic resistor, capacitor, or inductor, it is self-evident that the component's value is expressed in basic units of ohms, Farads, or Henrys, and the new code's design specification thus demanded the elimination of this superfluous 'postscript' data from the printed code *when used in circuit diagrams* (but not necessarily in normal printed text).

Regarding point (2) in the 'brevity' requirement, this was to be aided by using a fixed three-decade spacing between the decimal 'multiplier' units used to indicate a component's value.

Figure 7 lists the range of decimal multiplier units — using basic SI scientific notation and three-decade spacing — that are normally used in electronics, together with their normal prefixes, etc., and *Figure 8* shows how they are applied in the modern US Customary notation system (which was also widely used in pre-1975 Europe).

Note in *Figure 8* that the US Customary system uses three-decade multiplier spacing when notating values of resistance, inductance, frequency, and time, but inexplicably uses six-decade spacing (between μF and pF) when notating values of capacitance. This six-decade spacing is a major cause of the cumbersome capacitance-value notations (such as 0.001μF) that often appear in US circuit diagrams.

These, then, were the basic ideas behind the creation and development of the 1975 BSI component notation system, which today is known as the 'International' system. Let's now look at the details of the modern version of this system.

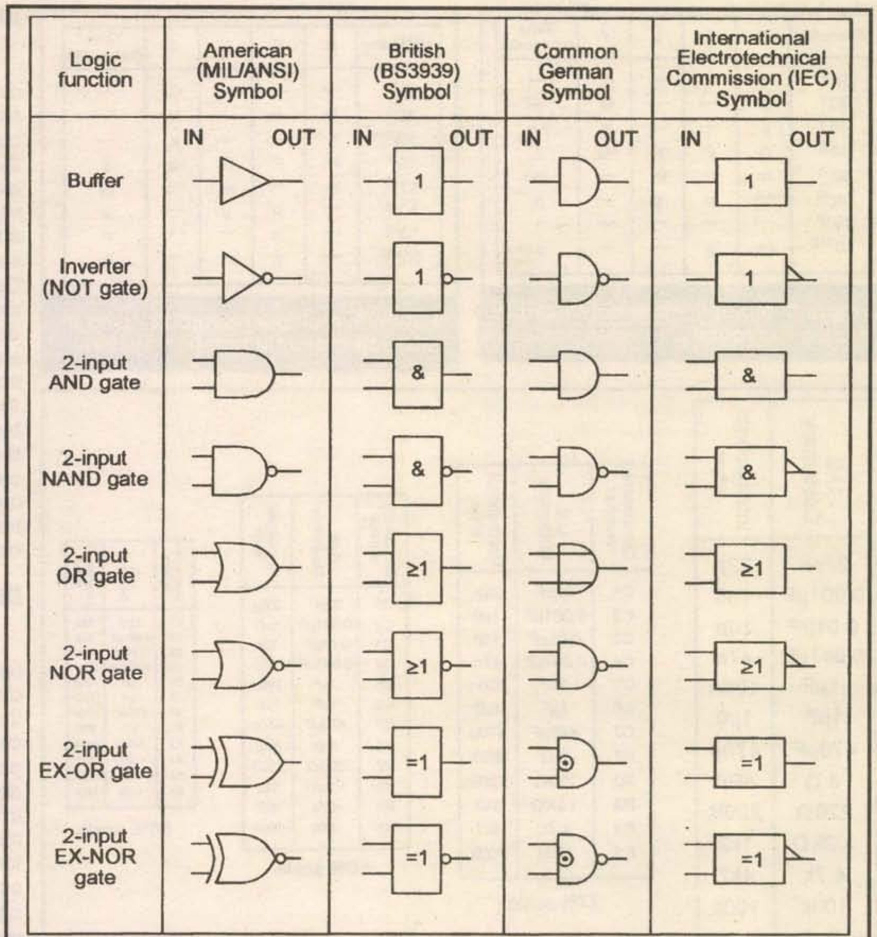


Figure 6. A selection of widely used logic symbols.

THE 'INTERNATIONAL' SYSTEM

RESISTANCE NOTATION

The standard unit of resistance is the ohm, named after a Bavarian, George Simon Ohm who, in 1827, published the results of his research into electrical resistance and whose name is commemorated by the symbol Ω (omega), which is the Greek equivalent of the Bavarian letter Ō. In 1975 (prior to the advent of the wordprocessor and CAD drawing), the symbol Ω was not carried on normal typewriters and was time-consuming to produce using normal drawing techniques.

Consequently, in 1975, the BSI recommended that the symbol Ω should no longer be used *on circuit diagrams* as a postscript when denoting resistance values, that *units* of resistance should be notated by the capital letter R, that *thousands* of units be notated by the lower-case letter k (for kilohm), and *millions* of units be notated by the upper-case letter M (for megohms). Thus, in this system, 47Ω, 47kΩ, and 47MΩ become 47R, 47k, and 47M.

CAPACITANCE NOTATION

The standard unit of electrical capacitance is the Farad, represented by the symbol F. In electronics, the Farad is too large a unit for general use and, prior to 1975, most capacitors had values that were expressed in units of a millionth of a Farad (μF) or a millionth of a millionth of a Farad (pF). Thus, 1μF equals 1,000,000pF. This six-decade space between basic multiplier units obviously results in excessively long component notations, and BSI recommended that this problem be elim-

Prefix	Symbol	Multiplier
giga	G	10^9
mega	M	10^6
kilo	k	10^3
(unit)	(unit)	10^0
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

Figure 7. Decimal multiplier scientific notations.

Multiplier	R	C	L	f	Time (seconds)
10^9	—	—	—	G	—
10^6	M	—	—	M	—
10^3	k	—	—	k	—
10^0	Ω	F	H	Hz	s
10^{-3}	m	—	m	—	m
10^{-6}	—	μ	μ	—	μ
10^{-9}	—	—	—	—	n
10^{-12}	—	p	—	—	p

Figure 8. Multiplier symbols used in the US Customary notation system.

Multiplier	R	C	L	f	Time (seconds)
10^9	—	—	—	G	—
10^6	M	—	—	M	—
10^3	k	—	—	k	—
10^0	R	F	H	Hz	s
10^{-3}	m	—	m	—	m
10^{-6}	—	μ	μ	—	μ
10^{-9}	—	n	—	—	n
10^{-12}	—	p	—	—	p

Figure 9. Multiplier symbols used in the International notation system.

inated by reducing the spacing between multiplier units to three decades, by introducing a unit known as the nanofarad (fully notated as nF), and equal to 1000pF. Thus, 1nF equals 0.001μF, and 1000nF equals 1μF.

In circuit diagrams, when indicating the value of a capacitor, it is self-evident that the component's value is expressed in Farads, and it is thus superfluous to re-state the fact in the diagram.

Component number	U.S. Customary	International style
C1	22pF	22p
C2	0.001μF	1n0
C3	0.01μF	10n
C4	0.047μF	47n
C5	.1μF	100n
C6	1μF	1μ0
C7	470μF	470μ
R1	8Ω	8R0
R2	220Ω	220R
R3	1.2kΩ	1k2
R4	4.7k	4k7
R5	100k	100k

100% scale

Component number	U.S. Customary	International style
C1	22pF	22p
C2	0.001μF	1n0
C3	0.01μF	10n
C4	0.047μF	47n
C5	.1μF	100n
C6	1μF	1μ0
C7	470μF	470μ
R1	8Ω	8R0
R2	220Ω	220R
R3	1.2kΩ	1k2
R4	4.7k	4k7
R5	100k	100k

77% scale

Component number	U.S. Customary	International style
C1	22pF	22p
C2	0.001μF	1n0
C3	0.01μF	10n
C4	0.047μF	47n
C5	.1μF	100n
C6	1μF	1μ0
C7	470μF	470μ
R1	8Ω	8R0
R2	220Ω	220R
R3	1.2kΩ	1k2
R4	4.7k	4k7
R5	100k	100k

66% scale

Component number	U.S. Customary	International style
C1	22pF	22p
C2	0.001μF	1n0
C3	0.01μF	10n
C4	0.047μF	47n
C5	.1μF	100n
C6	1μF	1μ0
C7	470μF	470μ
R1	8Ω	8R0
R2	220Ω	220R
R3	1.2kΩ	1k2
R4	4.7k	4k7
R5	100k	100k

50% scale

Figure 10. A selection of US Customary notations and their International system equivalents, reproduced at 100%, 77%, 66%, and 50% scales.

Consequently, the BSI recommended that, for component notation purposes, the symbol F should no longer be used *on circuit diagrams* as a postscript when denoting capacitance values, and that the scientific symbols μ, n, and p be used as basic multiplier units. Thus, in this system, 4,700μF, 47μF, 0.047uF, and 47pF become 4,700μ, 47μ, 47n, and 47p.

INDUCTANCE NOTATION

The standard unit of electrical inductance is the Henry, represented by the symbol H. In circuit diagrams, when indicating the value of an inductor, it is self-evident that the component's value is expressed in Henrys, and it is thus superfluous to re-state the fact in the diagram. Consequently, in 1975, the BSI recommended that — *on circuit diagrams* — the capital letter H should only be used to notate actual *units* of inductance, that *thousandths* of units be notated by the lower-case letter m (= millihenry), and *millionths* of units be notated by the symbol μ (= microhenry). Thus, in this system, 47H, 47mH, and 47μH become 47H, 47m, and 47μ.

DECIMAL POINTS

Decimal points sometimes become so severely degraded during the printing process that they cease to have a final practical value. As an example of this process, take the case of the decimal point associated with C1 in *Figure 1.* I originally generated this diagram in Corel DRAW vector format, with the C1 notations set in Arial text at 10-point size, under which conditions the decimal point takes the form of a 0.3mm x 0.3mm square.

To prepare this vector diagram for *minimum-cost* publishing, I then converted the drawing to Tiff 5.0 bitmap format at 300 dpi (in which the decimal point measures 4 x 4 pixels), and then scaled the bitmap to the '77% of original' size at which it is meant to be printed in *Nuts & Volts* (at which scale the point size reduces to 3 x 3 pixels). The complete bitmap was then printed out on high quality paper using a Laserjet printer and mailed off to *Nuts & Volts.*

On receipt of my artwork, *Nuts & Volts* scanned my bitmap into the magazine's printer, which then transferred the diagram to the printed page, where the decimal point probably measures 2 x 2 pixels, i.e., its size has fallen from 16 pixels to 4 pixels in the production process.

Thus, this minimum-cost artwork production process results in severe loss of the decimal point's definition. This problem can be reduced, at a much increased cost, by supplying the publisher with a disk copy of the full-scale Tiff 5.0 bitmap, which can then be fed — at an appropriate scale — directly into the publisher's printer, but even this process results in a final decimal point size of no more than 9 pixels at 77% scale.

The important thing to note from the above is that decimal points often become severely degraded during the printing process and, in their 1975 report, the BSI recommended that, for component/parameter value notation purposes, the decimal point should no longer be used and should be replaced by the basic component/parameter multiplier symbol (such as V, k, n, μ, etc.) applicable to that value. Thus, in this system, values such as 4.7V, 4.7kΩ, and 4700pF (= 0.0047μF or 4.7nF) become 4V7, 4k7, and 4n7.

AN OVERVIEW

There are four major differences between the International and US Customary notation systems, and two of these are illustrated in *Figure 9*, which shows the multiplier symbols that are used in the International system; compare this diagram with that of *Figure 8*, and note that the International system uses the symbol R to indicate basic resistance units, and uses the symbol n to indicate '*thousandths* of a μF' capacitance units.

Of the remaining two differences, one is that — in circuit diagrams — the International system does not use basic component 'type' symbols (such as Ω, F, or L) as component postscript notations, and the other is that the International system used the component's multiplier symbol in place of a decimal point in the actual component-value notation.

SPECIAL NOTES

Note that, although the BSI 'International' style of parameter-value notation was originally developed in the days when text was typewritten and circuit diagrams were hand-drawn, it still has great validity today, when text is generated on a wordprocessor and drawings are generated via a CAD package.

The US Customary notation '0.0047μF,' for example, looks clumsy, takes up lots of valuable text or drawing space, and takes 10 keystrokes to produce; the equivalent '4n7' International notation is, on the other hand, crystal clear, takes up a minimum of space, and takes only three keystrokes to produce.

Most real-life International component notation codes consist of two or more digits plus one symbolic 'multiplier' notation; thus, in *Figure 5*, resistance values of 10k and 10R and capacitance values of 100n, 10μ, and 220μ are used. When below-unity values such as 0.1 or 0.5μH occur, they are notated 0R1 or 0μ5 in the International system. Note that the use of a two-digit code loosely implies a two-digit degree of component precision; thus, if an 8Ω resistor is to be used in a semi-precision application, its value should be notated 8R0, but if it is only a very approximate value (such as a speaker impedance value), it can legitimately be simply notated as 8R.

The most important real-life tests regarding 'International' versus 'US Customary' component value notation systems are those relating to ease-of-use and final appearance on the printed page. You can only pass a fair comment on the first of these tests by making a genuine effort to get used to the International system, which is used by most engineers and electronics hobbyists throughout Europe and much of the rest of the world.

Regarding the second test, you can make a quick decision on this with the help of *Figure 10*, which shows a matching selection of International and US Customary component notations reproduced in extra-high-quality at 100% scale (full size), at 77% scale (the normal *Nuts & Volts* size), at 66% scale (the normal paperback handbook size), and at 50% scale (the normal small pocketbook size). Note the way in which the decimal points degrade in the smaller-scale US Customary notations.

I think the International notation system is the best of the two, and to help novice readers get used to it, future articles will, when appropriate, carry a small 'Beginner's Guide' box, giving a concise explanation of the International notation system (see *Figure 11*). If lots of readers continue to have problems, I will revert to the US Customary notation system in a future series. **NV**

Beginner's Guide to Component Notations

In this article, the values of resistors and capacitors, etc., are notated in International — rather than US Customary — style.

In resistance notation, the symbol R represents units of resistance, k represents thousands of units, and M represents millions of units. Thus, 10R = 10Ω, 47k = 47kΩ, 47M = 47MΩ.

In capacitance notation, the symbols μ, n (= 1000pF), and p are used as basic multiplier units. Thus, 47μ = 47μF, 47n = 0.047μF, 10n = 0.01μF, and 47p = 47pF.

In the International notation system, decimal points are not used in notations and are replaced by the multiplier symbol (such as V, k, n μ, etc.) applicable to the individual component value. Thus, 4V7 = 4.7V, 4k7 = 4.7kΩ, 4n7 = 4.7nF, and 1n0 = 1.0n.

Figure 11. 'Beginner's Guide' box, giving a concise explanation of the International notation system.

Don Lancaster's

RESOURCE BIN

number eighty three

Fun with some neat stuff.

Our usual reminder here that the *Resource Bin* is now a two-way column. You can get tech help, consultant referrals, and off-the-wall networking on nearly any electronic, *tinaja questing*, personal publishing, money machine, or computer topic by calling me at (520) 428-4073 weekdays 8-5 Mountain Standard Time.

There's sure a lot of neat electronics and related high-tech toys which are coming out lately. Both new and as surplus bargains. So, I guess we are overdue for a review of a lot of odds and ends that you just might decide are interesting or useful ...

Build Your Own Microprocessor!

Programmable gate arrays are now large enough and cheap enough that you can use them to create your own microprocessor, ending up having the power of, say, a 6502 or a Z-80.

Besides being a superb teaching or learning experience, your own micro lets you run your things your ways. Using any mix of conventional, RISC, or DSP tricks you select. There's also those sole source and security factors. Others are not likely to guess exactly what you've got inside the box.

Typical FPGAs of interest include the *Xilinx XC4005L*. A new firm going by the name of *Space-Time Productions* now has new hardware and software support systems which literally can let you design your own micro.

These are also distributed by *Ultra Technology* whose lines do include a variety of *Forth*-based products.

PSD Optical Rangefinding

There is great interest these days in sensing distances. Traditional optical rangefinders using *parallax* methods all had a serious flaw. In that moving parts were always involved. But it is possible to "inside out" the parallax method and make an all solid-state optical rangefinder. The trick is to use a special beastie called an infrared *Position Sensitive Detector*.

A pair of side-by-side plain old light sensors can even be used. You illuminate what you are measuring by using a laser or an infrared LED. You then arrange your optics so that your image moves across the sensor pair as the distance changes. The ratio of left to right output is trig related to your distance to the target.

NEXT MONTH:
Don looks at some possibilities in the medical electronics area.

There is one insider trick: To make the range signals independent of color and brightness, you'll *normalize* them by calculating (A-B)/(A+B). Leaving you with a *differential* output which is proportional to range only. Yeah, that division gets tricky to do analog, but is not that big a deal digitally.

Position sensitive detectors are sold by *Sharp*, *Hamamatsu*, and *Ricoh*. The *Sharp* GP2D02 is a good starting point. This chip is both low-cost and micro-friendly. Several of the intended apps include camera autofocusing, car "too close" alarms in garages, and even for use in restroom hand driers. More details and bunches of further optical rangefinding resources appear in *www.tinaja.com/glib/muse131.pdf.* More theory about optical and PSD rangefinding in general can be found in various SPIE publications.

Find That $#@$%# Cat!

The *Catfinder* is an interesting new take on mid-distance remote controls. There is a small hand-held transmitter and up to four light weight remotes. You place one on your cat's collar to keep tabs on tabby. Press the button and the cat meows.

Well, beeps actually.

Another intended use is for people who always lose things. You attach a receiver to, say, your VCR remote or your pager or whatever. When it gets inevitably misplaced, you find your Catfinder and then use it to find the remote. The claimed range is 50 to 80 feet, or the better part of half an acre. My own tests showed useful ranges, but were unable to reach their specified distances.

Cost is $29.00 for a transmitter and one remote. And $15.00 for extra remotes.

Your remotes get programmed to a selected channel by transmitting that channel while you install its coin cell battery. Programming is verified by a distinct double beep. The reasonably waterproof remotes are also optionally offered as contact closures rather than beepers. Leading to all sorts of remote controls.

Luminance Probes

When you measure light, you may want to sense *brightness*, finding out exactly how much light you have. But other measurement times, you might be more interested in how bright the light *appears* to a human observer. In this case, you'll be more interested in measuring *luminance*.

These two can be wildly different, because the human eye varies in its response to different colors. Your eye sees green strongest, red moderately, but blue only rather weakly.

Typical silicon photocells are very strong in the infrared but wimpy in the blue. To measure luminance, you have to carefully collect the light from the precise area you want to measure. Then you'll have to carefully filter the light to exactly match the response of the photodetector. A calibration curve is a must. Finally, you'll measure the amplitude transformed light and then convert its value to digits.

Luminance measurement is used in everything from architectural lighting to color video monitor balancing to getting colors to print out properly as grays. Your classic luminance probe has been that pricey *Tektronix* J6523. These have recently become available surplus in "almost new" condition at sane prices. These are narrow beam devices that include viewfinding and focusing. They work everywhere from 18 inches to infinity as is. By adding standard photo close-up lenses, tiny or nearby dots can be resolved.

They are intended to work with the old Tek J-16 digital photometer, but should be fairly easy to interface into nearly any DVM lashup or PC-based data acquisition system.

Class D Amplifiers

There's been many decades of false starts, but it finally looks like Class D amplifiers are here to stay. A Class D amplifier is basically a pulse width modulator that drives a high-power switch. Your switch is followed by a potent low-pass filter to recover your PPM audio. Advantages of class D are quite low standby current, ultra high efficiency, and the ability to use low voltages. Laptop computer stereo is an obvious new application.

SOURCES FOR UNUSUAL NEW CHIPS AND DEVICES

Analog Devices PO Box 9106 Norwood MA 02062 (617) 329-4700	**Hewlett-Packard** PO Box 10301 Palo Alto CA 94303 (415) 857-1501	**Medianix Semi** 100 View St Ste 101 Mountain View CA 94041 (415) 960-7081	**Ricoh** 3001 Orchard Parkway San Jose CA 95134 (800) 957-3436	**Tektronix** PO Box 500 Beaverton OR 97077 (800) 835-9433
Apex Microtechnology 5980 N Shannon Rd Tucson AZ 85741 (520) 690-8600	**Kepro Circuit Systems** 630 Axminister Dr Fenton MO 63026 (800) 325-3878	**Micro Linear** 2092 Concourse Dr San Jose CA 95131 (408) 433-5200	**Sharp** Sharp Plaza Mahwah NJ 07430 (201) 529-8757	**Texas Instruments** PO Box 655303 Dallas TX 75265 (800) 336-5236
Aremco PO Box 429 Ossining NY 10562 (914) 762-0685	**Lindberg** 304 Hart St Watertown WI 53094 (800) 873-4468	**MX-Com Inc** 4800 Bethania Station Rd Winston-Salem NC 27105 (800) 638-5577	**Space-Time Productions** 219 N Vale Ave Rockford IL 61107 msimon@tefbbs.com	**Tripath Technology** 3900 Freedon Circle #200 Santa Clara CA 95054 (408) 567-3000
Hamamatsu 360 Foothill Rd Bridgewater NJ 08807 (201) 231-0960	**Linfinity Micro** 11861 Western Ave Garden Grove CA 92841 (800) LMI-7011	**National Semiconductor** 2900 Semiconductor Rd Santa Clara CA 95052 (800) 272-9959	**SPIE** PO Box 10 Bellingham WA 98227 (206) 676-3290	**Ultra Technology** 2512 10th Street Berkeley CA 94710 (510) 838-2149
Harris Semiconductor Box 883 Melbourne FL 32902 (407) 724-7000	**Maxim** 120 San Gabriel Dr Sunnyvale CA 94086 (800) 998-8800	**Qualcomm/VLSI** 10555 Sorrento Valley Rd San Diego CA 92121 (619) 597-5005	**Synergetics** Box 809 Thatcher AZ 85552 (520) 428-4073	**Xilinx** 2100 Logic Dr San Jose CA 95124 (800) 244-7778

The *Texas Instruments* TPA005D02 is a good starting point. This $3.48 chip provides two watts output from a five-volt supply with under half a percent distortion. Other sources are *Harris*, *Apex*, *Linfinity*, and *Tripath*.

For a historical perspective on Class D, see my *Electronics World* story for February of 1966. A current listing of Class D amplifier resources appears in my MUSE128.PDF.

Load Banks

A *load bank* is simply a giant toaster. Several loaves at a time, even. These get used for resistive (or sometimes reactive) loads to test generators or windmills. And for industrial process heat. Or in student power labs. Or for alternate energy research.

Load banks come in several sizes. Um, it seems I picked up one that was a tad larger than I expected. Driving home why it *really* is a good idea to look at mil surplus before you bid on it. At any rate, this one is rated at 60 kilowatts and handles DC, normal AC, and three phase AC. This dude is available at three cents on the dollar. Terms like "sturdy" and "adequate" come to mind. Yes, it has wheels. Sort of. FOB Thatcher. Truck or trailer available. Lots more on load banks at *www.tinaja.com/bargte01.html*.

Whenever the Chips Are Down

There are great heaping bunches of new integrated circuits coming down the pike. Here's a few candidates that I find rather interesting ...

Analog Devices ADXL05 — A member of their new nanotech accellerometer family, useful for everything from measuring the earth's magnetic field to robot nav to air bags to premium microphones. Prices on these have finally dropped to reasonable. Free samples are sometimes offered.

Medianix MED25101 — Digital Karaoke Audio Processor. Huh? Apparently it strips vocals from existing recordings so you can sing along with them. This is really a 16-bit digital signal processor in drag. Includes a seven band graphic equalizer and soundfield simulation.

Maxim MAX4173 — One of their high side current sensors. Used to monitor battery or circuit current values and directions. Some do provide internal sensing resistors; others are externally controllable. The high side connection preserves system grounds.

Micro Linear ML4421 — It's a variable speed AC induction motor controller. The problem with speed control on a plain old AC motor is that you have to hold both amplitude and frequency in step with each other to keep the mag flux in bounds. Feedback sensing is also tricky. This chip seems to solve both problems quite well.

Analog Devices AD9830 — This digital sinewave generator is also known as a DDS direct digital synthesizer. You'll input a 16-bit digital word and get an analog sinewave back whose frequency is exactly controllable from near zero to around a third of its 50-MHz clock frequency. Uses the phase addition method where a selected value gets added to the ongoing result and sent to a sine lookup table.

Texas Instruments TSL235 — A single chip light-to-frequency converter has a sillicon photodiode and a current to frequency converter inside a single low-cost chip. Useful for measuring light intensity. Response is strongest in the red and infrared.

MX-COM MX805A — Unique Subaudio Signalling Processor lets you combine voice with very low-frequency digital commands. Based on CTCSS squelch tones. This little known outfit has all kinds of interesting and oddball chips for voice communication. Everything from cordless telephone scramblers to tone controllers.

National LM1971 — National, of course, has all sorts of unique low-cost and high-performance audio devices. This one is a digital audio attenuator, otherwise known as an electronic volume control. It works directly in decibels, and gives a 62 dB control range over a 115 dB dynamic range. Mute is also available.

Analog Devices SSM2163 — This new chip in their ongoing *Solid State Music* line is a complete high-performance audio mixer. The eight input channels can be sent in any combination to a pair of stereo outputs. Provides 63 dB attenuation in one dB steps. For multimedia, hi-fi, broadcast, paging, or musical instruments.

Qualcomm Q2220 — A second direct digital synthesizer for communication and audio uses. Qualcomm seems the leader in advanced digital radio and communications chips. They're also big in trellis encoders and similar low bit error rate devices.

More info on these can be found at *www.questlink.com* or else by viewing their respective web sites.

Some Other Toys

Here is some other stuff I've been recently playing with. Although once outrageously expensive, much of this is newly available as reasonable cost military surplus. Most of these have all sorts of "take it apart and make something new out of it" potential ...

Plotters — The older *Hewlett-Packard* pen plotters were once ridiculously expensive in larger sizes. These days, most people who can afford them do prefer the newer, faster, and vastly more flexible inkjet systems. But these old models still work just fine if you are on a low budget. Even in E-size, they are sometimes bargain priced and probably can be converted into such things as vinyl sign cutters or silkscreen mask makers as well.

Industrial Furnaces — Insulated boxes from *Lindberg* or *Aremco* easily hit temperatures of a thousand degrees or more and are now available at sane prices. Besides obvious arts and crafts uses, what can *you* do with one?

Space Shuttle Receivers — Data boxes which directly can receive 2287.5 MHz video are rather specialized, but these include a bandpass filter, attenuator, fancy receiver, even a quality power supply. There is all sorts of satellite monitoring potential here.

Telemetry Downlinks — Also known as Artery receivers, these unusual gray boxes offer lots of fancy fiber optic O combined with some expensive-looking small gold-plated VHF radio modules. Plus an easily modified 8035 computer and display.

Sick Optics — Most precision optics are extremely expensive. But sometimes you can find chipped or cracked items that work just fine for school demos or home experiments. For instance, badly mauled corner reflectors could often be masked or "stopped down" to create smaller and cleaner cubes. A retroreflector returns a light beam in the exact direction it came from.

Inclinometers —These sensors always know which way is up. Also known as *electronic levels*, the fancy rugged devices get installed on construction equipment for levelling. Some use the differential capacitance of a sloshing liquid in its butterfly-shaped sensor. The better ones are servo-driven null seekers. Lots of possibilities here.

Plate Thru Labs —Yes, it is possible to do your own double sided plate thru printed circuit boards. No, these are neither cheap or simple. *Kepro* is the leading source. These can sometimes be found as electronic surplus.

Tail Twisters — It turns out the HVAC air conditioning folks have long used power servos. Honeywell's Modutrol is one example. These are intended for damper controls, but are useful to open or close valves or similar apps. Typically moving 90 degrees in half a minute with up to 35 inch pounds of torque. This is the same as applying 17.5 pounds of twist to a three inch diameter valve handle. More on Modutrols in MUSE130.PDF.

Mystery Beer Coolers — Not sure what these are, but the feds got conned into paying $21,000.00 for the pair of them. They called them "ion gauges." Maybe so, maybe not. Try to picture a liquid hydrogen Dewyer around 18 inches in diameter and two feet high. A special probe reaches inside via an expensive looking vacuum fitting. There's some small electronics externally attached. EG&G Ortec is the brand. Definitely for sale cheap. You can use it for superconductivity demos or low-noise amplifier experiments. For more details, contact *casholsen@zianet.com.*

Huge Light Bulbs — Airport beacons at one time needed large and impressive 1200-watt incandescent lamps. These are now cheaply available and make superb test loads, process heaters, or high intensity lights. These also seem just bizarre enough to make a rather nice "monode" addition to an antique vacuum tube collection

Extension Phone Lockouts — These low-cost 2960 modules from the *Northern Telecom* folks include a pair of 17-volt bilateral switching diodes. One use is to stop a picked up extension phone from blasting an ongoing modem or fax. Full schematics and more device details can be found in MUSE96.PDF and MUSE112.PDF.

Mechanical Timers — Stock "washing machine" timers consist of a small AC motor and scads of fairly heavy duty cam-driven contacts. They are easily converted into such things as hot tub, farm, or irrigation controllers. It's a real challenge to discover what you *really* can do with these beasties. New ones are readily available surplus or try your local dump.

Two Contests

Let us have two different contests this month. First, the Catfinder folks have agreed to a special contest only for readers of my columns. Just tell them something new or unusual that you'd like to do with one or more catfinders. They'll award a dozen or more free evaluation units to what they feel are the most interesting.

Send all of your entries on this one *directly* to the Catfinder address in the sidebar, or E-Mail *jgcurtis@inreach.com*. Getting back to the usual stuff, just tell me about any fresh new tech toy you've found to play with. One that I haven't heard of before. There will be a dozen or more of my *Incredible Secret Money Machine III* books going to the better entries. Plus an all expense paid *tinaja quest* for two (FOB Thatcher, AZ going to the very best of all.

Send your written and snail-mailed entries on this second contest directly to me here at *Synergetics*. Please be sure to keep these two contests separate.

Let's hear from you. **NV**

*Microcomputer pioneer and guru Don Lancaster is the author of 35 books and countless tech articles. Don maintains his no-charge US tech helpline found at **(520) 428-4073**, besides offering all of his own books, reprints, and consulting services. Don is the webmaster of his Guru's Lair found at http://www.tinaja.com.*

You can reach Don at Synergetics, Box 809, Thatcher, AZ 85552. Or send any messages to don@tinaja.com.

Newsbytes

COMPLIANCE AND INFORMATION ACTION

Ship radio inspections to be privatized.

In compliance with the requirements of the Telecommunications Act of 1996, the Commission has amended its rules to permit it to use FCC-licensed technicians in private sector organizations to inspect all US ships required to be inspected for compliance with the Communications Act of the International Convention for the Safety of Life at Sea.

Commission inspectors currently conduct inspections of a ship's required radio equipment for compliance with the Communications Act or the Safety Convention.

The FCC inspects approximately 1210 vessels each year. To be in compliance with the current rules – that require that all inspections be conducted by the Commission – the FCC has had to hire part-time ship inspectors in remote areas such as Guam and has traveled great distances to inspect radio stations on US ships.

The Commission estimates that total annual personnel required to inspect these ships is 15.5 full-time employees and travel costs to be $50,000.00 a year. The new rules will relieve the FCC of these manpower and financial burdens, while permitting vessels the more convenient and cost-effective alternative of using FCC-licensed technicians from the private sector for inspections.

The new rules incorporate requirements suggested by the United States Coast Guard to ensure that maritime safety is not compromised. The new rules result in the following benefits:

- Privatization will increase the number of experienced entities available to inspect the radio stations of ships.
- Privatization will permit ship owners and operators to arrange for inspections at any time or place.
- Privatization should not adversely affect safety. The rules incorporate changes suggested by commenters that will require the use of a standard inspection check list with the FCC maintaining oversight of the inspection process as suggested by the US Coast Guard.
- Privatization will decrease administrative burdens on the Commission by shifting the responsibility to arrange ship inspections from Commission to ship owners or operators.

MICROTECH ANNOUNCES USB-TO-SCSI CONVERTER

Low-cost connectivity solution brings flexibility to iMac owners.

Microtech International will now manufacture and ship a converter cable that allows SCSI storage devices to be connected to a standard USB port. The Microtech Xpress USB is a USB-to-SCSI converter which targets the hundreds of thousands of new iMac owners who may own older SCSI peripherals, such as hard drives, SyQuest, CD-ROM, or Iomega Zip and Jaz cartridge drives.

With an MSRP of just $79.00, the USB-to-SCSI converter offers an affordable solution, filling a void created by the connectivity limitations of the iMac.

The converter is designed as a cable with a standard USB connector on one end, and a male SCSI DB25 connector at the other. The SCSI connector is attached to the external drive and the hot-swappable USB connector is plugged in to the CPU or hub. The connector supports up to seven devices in true plug-and-play fashion, recognizing devices on the fly without requiring users to restart the computer.

The Xpress USB is fully compliant with the USB spec version 1.0, and delivers a maximum data throughput rate of 1.2MB/sec.

The first release of the software driver for the connector will support storage devices including Winchester drives and all removable media solutions. Microtech also promises an aggressive development schedule for driver updates and expects to support scanners and other third-party devices in upcoming revisions. All driver upgrades will be free-of-charge and available for download from the Microtech website.

Specific questions regarding compatibility and product support can be directed to Microtech Technical Support at 1-800-666-9689, or via E-Mail at nagy@microtechint.com.

Microtech expects to be shipping in volume on January 4, 1999, in time for MacWorld San Francisco. Units will be available through standard distribution channels, including Ingram Micro and Pinacor.

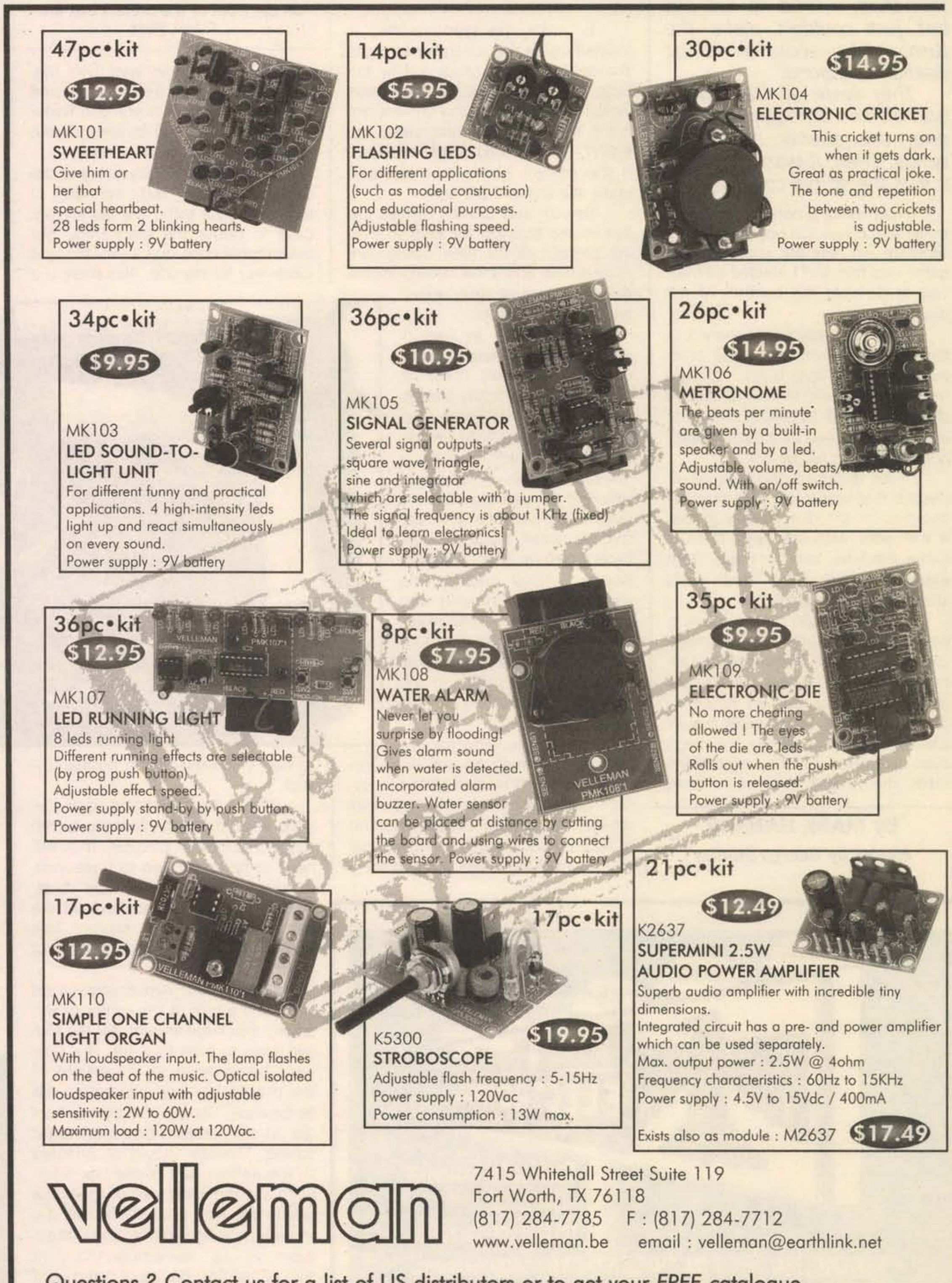
Information on all Microtech products is available at: http://www.microtechint.com.

TELEVISION COMMERCIALS FOR THE INTERNET

COMMERCIAL TV.COM now has available INTERMMERCIALS on the Internet. This is a new form of television commercial geared for the Internet. Commercial TV.Com is an Internet company that deals with surveys of television commercials and intermmercials on the Internet.

It is assumed the Internet will soon become the focal point of many households and corporations. Currently, commercials are produced for the television industry, but many companies are shifting gears to ride the high profile Intermmercials and the mass exposure at a cost-effective price that the Internet will offer.

Give Commercial TV.Com a call at 1-800-700-8749 if using intermmercials as a mass marketing tool applies to your situation. ***NV***



Build AN AIR JOYSTICK

It occurred to me, as I looked out the cockpit of my P-51 Mustang, that my plane's controls were kind of sluggish. However, off in the distance, I could see the German ME-109s coming at me in attack formation. I tried to roll out but just couldn't make the turn. My controls just wouldn't respond.

They were all over me. I was hit and hit again. One by one, the enemy strafe my wings. Then, it was all over ... it was the stupid controller.

I was using a normal Sega controller and it was just not designed to simulate an aircraft joystick. The game was fine, but I needed a better way to simulate the controls of the plane.

There are joysticks out there, but they all suffer from the same problem: They use two hands. What I needed was a one-handed joystick. It should respond by tilting the grip, but be constrained by a base. What I needed was an *air* joystick.

I have designed and built an air joystick that works by using mercury switches for the directional controls. It will work with any Sega Genesis game machine, can be made from easily-obtained parts, and costs about $15.00 to build.

Before we build our air joystick, we must understand how the Sega controller works. The normal controller has eight switches in it: four for direction and four for functions (A, B, C, START). These eight signals are transmitted back to the Sega over six wires in the controller's cable. The other three wires are used for ground five volts and a control signal.

by MARK HANSLIP
Photos by George Stanley

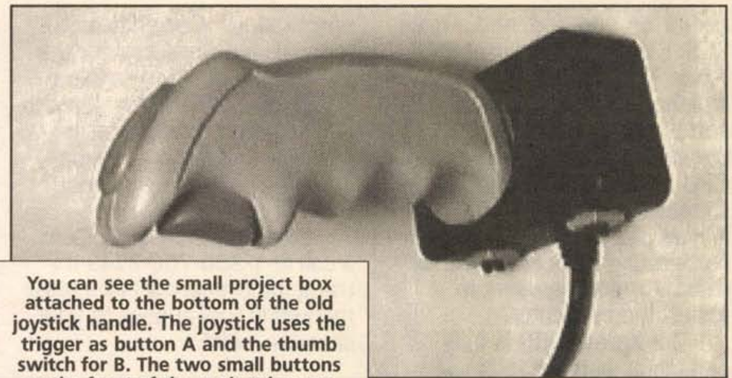
Since eight signals must be sent over six wires, the signals are arranged into two groups: A and B. The control signal sent from the Sega indicates which signals are requested.

To make this work, a chip is located inside the controller to route the correct signals requested by the Sega. The chip works like four relays working together. If the control signal is in a high (five volts) state, the RIGHT, LEFT, A, and START are sent. If the control is in a low (ground) state, the B and C are sent.

The UP and DOWN signals are not routed through the chip so they are present all the time. Some controllers have additional circuits to produce a machine gun effect with the fire buttons.

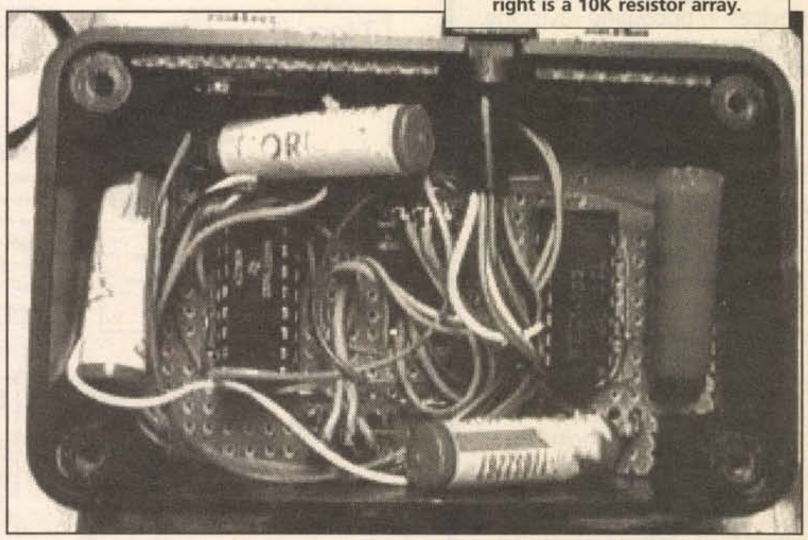
To make the air joystick work requires mercury switches (see Safety Note). These are similar to the mercury switches found in most home thermostats or silent light switches. As the switch is tilted, a tiny blob of mercury rolls from one end to the other inside a glass tube. At one end are two or three electrical contacts. When the mercury switch is tilted enough, the mercury rolls to the end with the contacts and completes the circuit. By positioning four mercury switches so each one represents one switch in the directional control, we can create a joystick.

I started building my joystick by obtaining an old, dead joystick. It doesn't matter what the joystick originally connected to since all we want is the grip. I found mine on a RadioShack clearance table, but any type will do. I was looking for a joystick that had at least two triggers; one for the index finger and one for the thumb. If you can find a joystick that has two or three thumb switches, that will work better.



You can see the small project box attached to the bottom of the old joystick handle. The joystick uses the trigger as button A and the thumb switch for B. The two small buttons on the front of the project box are C and Start.

Disassemble the joystick and discard everything but the grip. I thought about using the old joystick base to house the electronics, but the original base was oversized and too heavy for my use. Also there is a tendency to use it like a normal joystick.



This photo shows the electronics inside the air joystick. The small mercury switches (small tubular) are visible along the walls of the project box. They are tilted at approx. 30 degrees. The 74LS157 is the chip on the left while on the right is a 10K resistor array.

When disassembling the joystick, keep the wires running to the triggers as long as possible. They will need to be about two to three inches long. If the wires are too short, open up the handle and extend the wires. The smallest project box RadioShack sells is perfect for our use.

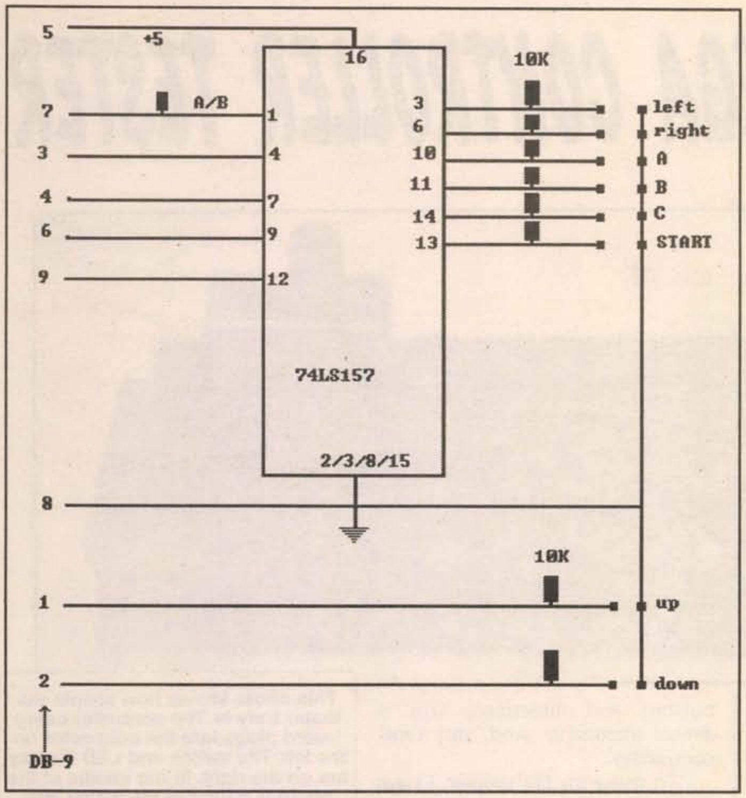
Based on the joystick you started with, drill a hole in the center of the project box large enough for the trigger wires to pass through. This hole must be centered so the weight of the project box and electronics will be balanced. Attach the joystick handle to the project box with small screws. The box should be oriented so the narrow part of the box is forward and the wider part of the box is side-to-side (see photo). This will distribute the weight better and make it easier to use. Remember this joint should not flex, but must stand up if someone grabs it by the base.

Now we must trim the PC board to fit into the box. I used a utility knife and nibbling tool to trim the board to fit within the box. This might take several tries of trimming and test-fitting before the board fits correctly. When the board is finished, it should fit snugly at the bottom of the box. Drill a hole in the center of the PC board to accommodate the trigger wires as they pass through the box. The PC board will be the support and connection for all the remaining components.

Start by positioning the mercury switches so that each switch is at the edge of one main axis (up, down, right, left) of the PC board. It is best to position each switch so they all point in a clockwise or counter-clockwise fashion. This way each will rep-

SAFETY NOTE

Mercury switches are made of liquid mercury encased in a glass capsule. Care must be taken to see they are handled properly. Mercury switches are safe as long as the glass remains unbroken. MERCURY IS A DANGEROUS SUBSTANCE AND SHOULD NOT BE HANDLED FOR ANY LENGTH OF TIME. If a mercury switch becomes damaged or breaks, contact local authorities about disposal. UNDER NO CIRCUMSTANCES dispose of mercury switches in a fire, as mercury vapor is very poisonous.



resent a different direction.

To illustrate, if the switches point in a clockwise direction (contacts attached to the PC board, tips hanging down), the 12 o'clock position will represent LEFT. Remember the tips of the switches are hanging down, so when the board is tilted to the left, the switch rotates to a level position and completes the circuit. Similarly, the switch in the 3 o'clock position represents UP, 6 o'clock represents DOWN, and 9 o'clock represents RIGHT. I have found that a 30-degree angle from the board is the best for play. Once the switches are in position, a small blob of caulking will hold them at the correct angle.

The only other components inside the project box are the 74LS157 and pull-up resistors. I found it best to use a IC socket, so the heat from soldering won't damage the chip. Next, solder all connections from the socket to the resistors and mercury switches as indicated on the schematic. I used a resistor array since I needed nine resistors, but individual ones are just as good.

Solder the connections from the cable to the appropriate locations. A small notch must be made in the front edge of the project box so the cable can exit. If the cable has a molded-on strain relief, the notch should be big enough so the strain relief is firmly seated in the notch and doesn't wiggle.

If your joystick handle has only two triggers, mount two small push buttons on the front of the project box, on either side of the cable. These will be the buttons for C and START. Solder wires from these switches to the PC board. Solder the trigger switches to the PC board. The index finger trigger will be A and the thumb will be B. In my version of this, I used connectors for the trigger connections so the board can be disassembled conveniently for repairs or adjustments, if necessary. Finally, plug in the chip, remembering the correct orientation of pin 1.

Testing the new joystick can be accomplished in several ways. If you have a game that makes use of directional buttons in an easy discernible way, this will work. Initially, I used

List 1: CONTROLLER SIGNALS

PB-9	SIGNALS
1	UP (both a and b)
2	DOWN (both a and b)
3	LEFT (b) unused (a)
4	RIGHT (b) unused (a)
5	+5 volts
6	"A" (a) "B" (b)
7	CONTROL PIN A=GND B=+5
8	GROUND
9	"START" (a) "C" (b)

List 2: PARTS LISTRADIOSHACK #

OLD JOYSTICK GRIP	
SEGA REPLACEMENT CABLE (see below)	
PC BOARD	276-158
SMALL PROJECT BOX	270-230
9 10K 1/4W	271-1335
2 SPST push buttons	275-1571
74LS157 (see below)	
4 mercury switches (see below)	
16 pin IC socket	276-1999

Small mercury switches can be obtained from Mendelson's Electronics, Catalog Sales, #540-6220; 1-800-344-4465. Sega replacement cables (#83-28;5) and the 74LS157 are available from MCM Electronics, 1-800-543-4330.

the game Shove-it. The speed of the game was slow enough that my movements were easy to detect and I could see if the movement was correct. Games that require lots of fast movement will not work since your movements can't be tracked accurately.

The other way to test the joystick is to build a tester that will light an LED for each movement or button push. This tester can be as simple as a resistor and single LED or a device that will test all the functions of a controller at once. If you supply the joystick with ground, five volts, and a control input, a single LED can be used to see if the signal from a movement or button push is present on the correct pin.

If your joystick doesn't work perfectly at first, check for solder bridges and broken wires. Possibly the chip could be in the socket backwards. The angle of the mercury switches will affect how much they have to be rotated before a signal is returned. One mistake I made was to wire the UP and DOWN switches in reverse.

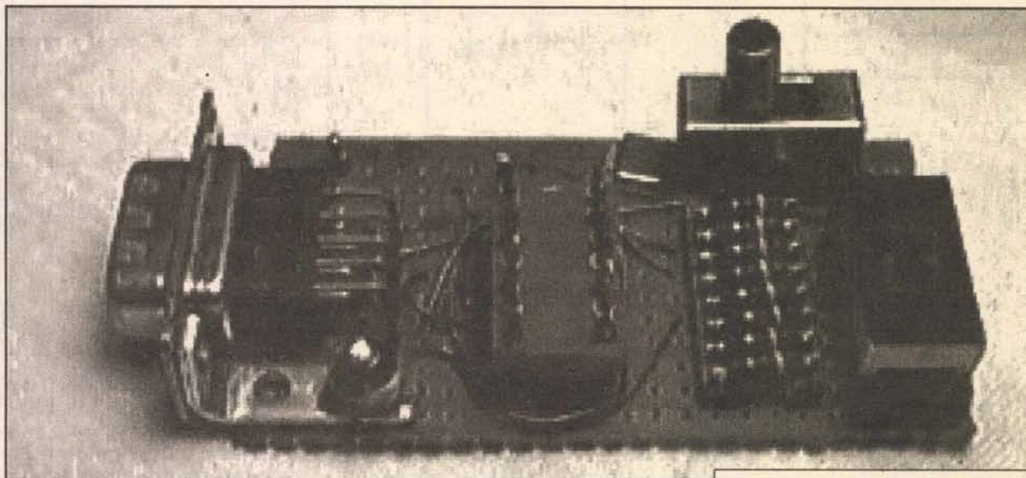
I was testing it on a aircraft flight game , so when I tilted forward, I normally expected the plane to descend and tilting back made the plane climb. This is correct for an airplane, but I found out that this is backwards for games. I re-wired the joystick. It was easier to think of it as a tank joystick where UP is forward and DOWN is reverse. By re-wiring, it makes it work like all other game controllers. It would be possible to add a DPDT slide switch to swap the UP and DOWN signals as required.

Now that you have your new air joystick, put on your VR helmet and fly that mission like it was meant to be flown, and kill a few bad guys for me ...

Build A SEGA CONTROLLER TESTER

by MARK HANSLIP

Photos by George Stanley



This photo shows how simple the tester truly is. The controller being tested plugs into the connector on the left. The switch and LED display are on the right. In the middle of the board is a jumper block that was originally used to test the tester.

"Dad, the Sega controllers are messing up again. Can you fix them please?" Oh, the joys of being a parent. It amazes me how much abuse a video game control can take, and even more how much my son can dish out. I have replaced cords, contact pads, and a variety of other things.

The problem with repairing game controllers is that you never quite know if the trouble is in the controller, the cable, or the machine itself. And once you have fixed the controller, you are not always quite sure if it's truly repaired. There is always the contact pads that shift and wires that get pinched.

The only way to test your repairs is to use the controller with a game that allows you to test all the buttons and directions. This is almost impossible. And, very time-consuming.

To make my life simpler, I have designed a controller tester. It connects up to any Sega game controller and will display the output of all the buttons when pressed. This allows me to test the controller and find the problem, then test it later and see if my repairs have worked. The design is simple and easy to construct. I built mine in less than an hour with parts I had on hand.

A Sega controller uses a DB-9 female connector. Being a standard connector, this makes finding a mating connector very easy. The Sega was designed so that eight switches in the controller are attached to six wires in the cable. This means that sometimes two signals share one connector pin. To make this work, the Sega toggles pin 7 to enable the "A" or "B" set of signals. The tester takes this into account by using a slide switch to simulate the toggling of pin 7. A 555 could be used to continuously toggle the control line, but this would make the circuit more complicated and make the output harder to read. The signals for each connector pin are located in List 1.

The basic circuit has +5 volts; ground and the control signal are outputs to the controller under test. The six outputs returning from the controller are connected to LEDs for display. I decided to use a seven-segment display to keep the design

List 1: CONTROLLER SIGNALS

PB-9	SIGNALS
1	UP (both a and b)
2	DOWN (both a and b)
3	LEFT (b) unused (a)
4	RIGHT (b) unused (a)
5	+5 volts
6	"A" (a) "B" (b)
7	CONTROL PIN A=GND B=+5
8	GROUND
9	"START" (a) "C" (b)

List 2: PARTS LISTRADIOSHACK #

PC board	276-158
DB-9 male	276-1538
6 220 ohm 1/4Ww	271-1313
2.2K 1/4W	271-1325
Seven-segment display	276-075
Common anode (or 6 individual LEDs)	
SPST switch	275-645
14 pin IC socket	276-1998

List 3: REPLACEMENT PARTS SOURCES

Parts to repair Sega controllers can be obtained from MCM Electronics, 1-800-543-4330 (Cable 83-385; Contact pads 83-1580).

List 4: LINEOUT FOR SEVEN-SEGMENT DISPLAY

PIN	USE
1 TOP	UP
2 UPPER LEFT	LEFT
3 +5	
7 LOWER LEFT	A/B
10 LOWER RIGHT	C/START
11 MIDDLE	DOWN
13 UPPER RIGHT	RIGHT
14 +5	

small and simple. I used the upper part of the "*" to display the directional controls. The top LED is "UP," the middle bar is "DOWN," the left LED is "LEFT," and the right LED is "RIGHT."

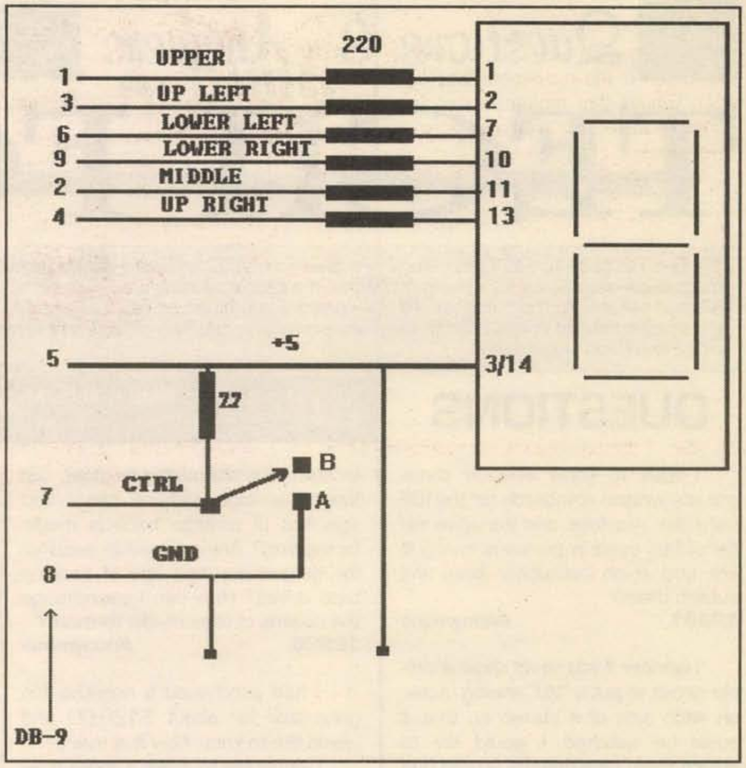
I used the lower left and right as the display for the A, B, C, and START buttons. An external power source of +5 volts will be needed to power the controller and tester. Sega controllers contain a 74157 IC so the operating voltage cannot vary too much from +5 volts. A possible alternative is to use a nine-volt battery and a five-volt regulator.

To test a controller, plug it into the connector on the tester. Set the switch to "B" (five volts) and start by pressing each of the direction buttons. With each press, the corresponding LED should light. Next, press "B" and "C." These should each light a lower leg of the display.

To test the "A" set, slide the switch to the "A" position. The upper right and left LED will light and stay on, but the top and middle LED will still respond to the normal directional buttons. This is normal. Pressing the "A" and "START" buttons will each light one of the lower legs of the LED display. If any LEDs fail to light when the appropriate button is pressed, a problem has been found within the controller.

This tester will save you a tremendous amount of time. It will help you to correctly replace contact pads, locate broken cables, and other problems with controllers.

It even helped me build and test a special joystick for my son, but that's another story ... **NV**



Questions & Answers

TECH FORUM

This is a READER TO READER Column. All questions AND answers will be provided by *Nuts & Volts readers* and are intended to promote the exchange of ideas and provide assistance for solving problems of a technical nature. All questions submitted are subject to editing and will be published on a space available basis if deemed suitable to the publisher. All answers are submitted by readers and *NO GUARANTEES WHATSOEVER* are made by the publisher. The implementation of any answer printed in this column may require varying degrees of technical experience and should only be attempted by qualified individuals. Always use common sense and good judgement!

QUESTIONS

Send all material to **Nuts & Volts Magazine**, 430 Princeland Court, Corona, CA 91719, OR fax to (909) 371-3052, OR E-Mail to **forum@nutsvolts.com**

I want to know whether there are any written standards for the IDE hard disk interface, and the universal serial bus used in personal computers, and which institutions keep and publish them?

12981 **Anonymous**

I wonder if you could show a simple circuit to put a "VU" analog meter on each side of a stereo so that it could be watched. I would like to attach them between the stereo and the speakers, and be able to adjust the meters sensitivity, if possible.

12982 **B. E. Holtermann**
Bena, VA

On the Internet and in other documents, I see the use of the TCM3105 202 modem chip. It works well, but appears to be out of production. Is it second sourced or does someone have a big stash of them?

12983 **Neal Collier**
Pensacola, FL

I need the specs on GP1U52X IR receiver/demodulator, or at least the name of the manufacturer. I am trying to build an IR switch.

12984 **Bhavesh Parikh**
via Internet

I am looking for an inexpensive outbound call monitoring system, one that will keep a record of the numbers dialed from a given phone, along with the date and time of the call. I need to handle about 200 calls before any storage medium is overflowed.

RadioShack used to market a small unit that recorded the data on a roll of paper, but they do not offer it any longer. Inexpensive is the key here. While a stand-alone unit is preferable, a computer can be made available if needed. Kits or simply plans will also be considered.

12985 **Steve Bepko**
Baltimore, MD

I have a TEAC 700 computer back-up tape drive that works fine with a 3010 formatted tape. How can I low- level format a QIC Wide (as cartridge modified) or QIC 80 tape?

Using Arcada or Microsoft back-up software, the head of the tape is located, but the software does not format a tape. Where can I find specifics of strange back-up media formatting? Are programs available for general-purpose use of back-up tape drives? How can I interchange the dozens of tape media formats?

12986 **Anonymous**

I had purchased a negative Ion generator for about $120.00 and would like to know how it is made.

I would like to make a more powerful one. It looks very simple, but the parts are encased in a hard plastic with no markings on the outside.

12987 **Patrick McGuinn**
via Internet

I need a simple countdown circuit to count from a preset value of 2-12 to zero. It needs to provide an output at zero. Levels are no problem. I can adapt to the voltages I need.

I have been out of this stuff for a long time. Last time I did this, I used a motor driving a disk with a wiper!

12988 **Dave Schoepf**
Marianna, FL

I was given a Genigraphics film recorder model# F.R. PSM 3 Rev.G. It included an ISA card. Does anyone know where I can get drivers for it?

12989 **Richard Coppola**
Bayside, NY

I have an enormous (24 lbs.) FUJITSU model M2312K 8" hard drive part# B03B-4595-B002A, date 1985-3. I am really curious about the specs on this piece of history — speed, interface type, capacity, original computer, etc.

129810 **Richard Coppola**
Bayside, NY

I have a number of exhibits that rely on NiCad rechargeable batteries. Consequently, each manufacturer prescribes a different preferred schedule for recharging the battery, which I have followed (recharge as little as possible vs. keep at maximum charge, charge no longer than seven hours vs. always keep charged).

Is there any generally preferred schedule, or should every battery be treated per its instructions?

129811 **Thomas Ng**
San Jose, CA

I recently acquired an RCA CCTV camera model TC101 and monitor model TC1112. The system worked fine until the monitor failed.

I am seeking the following information: **1**. What type of adapter to buy or build so the camera can be used with a standard TV monitor (there is a sync conflict)? **2**. A service manual or schematic of the original monitor.

129812 **Joe Pitman**
via Internet

A while back, I remember reading either an article or a reader's comment in *Nuts & Volts* about those stripes that are in the new money. Can anyone with the proper scanner "scan" you or your house to see how much money you have?

129813 **Dave Mikesch**
via Internet

I am looking for two schematics that are relatively simple, but currently beyond my ability to manufacture.

1. A circuit that would power a very loud sonalert-type device (regularly timed pulses versus a continuous tone) that I could mount in my model airplanes so I have an audible tracking aid when and if I lose another one.

2. A simple timer that would activate with one SPDT switch that would beep once at one minute from the time it was started, twice at two minutes, and so on up until about 20 minutes or so.

If someone could tell me where to find such a circuit. I can build it, I just can't design it.

129814 **Tom**
via Internet

I am trying to interface various sensors/transducers to the serial/parallel ports of my IBM-clone.

A major improvement would result if I could (temporarily) modify the system-boards 8253 timer IC, so as to generate interrupts every 0.1 milliseconds, instead of the standard 55 millisecond limit.

Can this be done at all? I know "C" fairly well, but when I tried outport b() to the 8253 (assuming the control register is at addresses 0x043 and the third counter is at 0x42), nothing happened. Any suggestions?

129815 **Thomas Ng**
San Jose, CA

Does anyone know how to build a code scanner for Mitsubishi cars? The scanners for other makers are available now.

129816 **Yan Wu**
Boston, MA

I have a couple of data loggers which record a 0-5V DC signal, at 20 samples per second. Unfortunately, the sensors I would like to use with

ANSWER INFO

- Include the question number that appears directly below the question you are responding to.
- Payment of $25.00 will be sent if your answer is printed.
- In most cases, only one answer per question will be printed.
- Your name, city, state, and E-Mail address, (if submitted by E-Mail), will be printed in the magazine, unless you notify us otherwise with your submission.
- Due to space limitations, we can not reprint the original questions with the answer. The question number and the issue it appeared in are printed above the answer.
- Unanswered questions from a past issue may still be responded to.
- Comments regarding answers printed in this column may be printed in the Reader Feedback section if space allows.

QUESTION INFO

TO BE CONSIDERED FOR PUBLICATION

All questions should relate to one or more of the following:
1) Circuit Design 3) Problem Solving
2) Electronic Theory 4) Other Similar Topics

INFORMATION/RESTRICTIONS

- No questions will be accepted that offer equipment for sale or equipment wanted to buy.
- Selected questions will be printed one time on a space available basis.
- Questions may be subject to editing.

HELPFUL HINTS

- Be brief but include all pertinent information. If no one knows what you're asking, you won't get any response (and we probably won't print it either).
- Write legibly (or type). If we can't read it, we'll throw it away.
- Include your Name, Address and Phone Number. Only your name will be published with the question, but we may need to contact you.

these data loggers produce various outputs, (i.e., 0-50MV DC, 0-500MV DC and 0-1V DC.

I would like to construct or purchase ready made, what I believe would be called a linear DC amplifier with the inputs mentioned above and a 0-5V DC output that I could connect to my data logger. Can anyone help me?

129817 **Peter Marsh**
via Internet

I have a piece of test equipment that has the GPIB interface. I want to use the GPIB to download data from that equipment to my PC. Can I accomplish this with a bi-directional parallel port, or do I have to shell out $400.00+ for a GPIB board? I am capable of writing the driver myself, but if this were possible someone must have done it. Any input?

129818 **Bill Eaton**
Hamilton, OH

I enjoy reading and building projects in the *Nuts and Volt* magazine. I especially like the articles involving the BASIC Stamp and general articles on using serial and parallel ports to control projects.

I have read articles in the past to change a SVGA monitor to a RGB, but I don't know if the reverse is also possible.

I have a digital 19" monitor model #VR 299-DA manufactured in June 1990. The monitor has three BNC connectors (RGB) on the back. Other information Hz: 50-60, W: 150, V: ~100-120, A: 2.2.

I was interested in hooking the monitor up to my computer SVGA output. Is this possible? What will it take?

129819 **Matt Droter**
via Internet

Apple II emulators for the IBM PC require that images of the Apple diskettes be stored on the PC. I would like to build a hardware/software interface that would allow me to create these images by directly reading an Apple floppy drive connected to a PC via the parallel port or expansion bus.

Does anyone have details on how this could be done? Are there any detailed hardware manuals available for the Apple drive that would help me develop my own interface?

129820 **John Reynolds**
via Internet

I have an old drawing program called DR HALO. I used it for drawing circuits and such. I would like to convert these drawings I saved in DR HALO format (PIC), to the new standard of BMP, PCX, TIF. I have been hunting for a conversion program for five years now.

The program CSHOW ver 8.76a will recognize the PIC format, but I can only view the drawings.

Does anyone know of a conversion program for this type of format and where I could get it?

129821 **Terry Baker**
St. Paul, MN

I have an OPTREX DMF-633 display that I would like to interface with. I would like to know if there are any circuit examples of using an EPSON SED1330 or SED1335 controller with this display.

129822 **Anonymous**

I have an old 486 motherboard that I would like to use in a robot. When the robot is running, I would like to unhook the keyboard and monitor. How can I bypass the keyboard and monitor? I have looked through the bios, and there is no way to turn it off.

129823 **Brent Lamb**
Lubbock, TX

I read Karl Lunt's March and April '98 articles on hacking the GameBoy.

I tried looking on Jeff Frohwein's web page and his links, but I can't find something.

Do you know where I can get info on hacking the GameBoy Camera? I want to use it for very crude object recognition — with or without interfacing to the GameBoy.

Any schematics, pinouts, or code related to the GameBoy camera would be really helpful.

129824 **Jim Awrach**

ANSWERS

ANSWER TO #10985 - OCT. 1998

In response to Robert Ritchey's question on the jumper settings for his Magitronics Motherboard. He can contact the company by writing: **Magitronic Technology**, Inc., 6585 Crescent Dr., Norcross, GA 30071; **1-800-4-LIUSKI**. They are the parent company to Magitronics.

They also have web sites which E-Mail inquiries can be made, as well as information and files on their products can be obtained.

I checked the site and the product Robert has, it is outdated and not supported on their web page. But they do state that if you contact them on older motherboards and give the information he gave in his question, they would fax or mail the information on the motherboard jumpers if they still have it available. Their web page is http://www.magitronic.com or http://www.liuski.com.

Wesley K. Miller
Camp Hill, PA

ANSWER TO #10987 - OCT. 1998

The 8909-02A microprocessor reads the push buttons and signals from the remote control and programs the TV accordingly.

This IC is found in Goldstar Chassis NC-91A and is available from: **Shine Electronics**, 11-22 45th Rd., Long Island City, NY 11121; **1-800-243-0000**.

This identical chassis family is used in the J.C. Penney model 2193 (685-2193; Catalog No. 855-9007) and the IC is available from: **Cititronix**, 1641 Dielman Rd., St. Louis, MO 63132-1597; or Panson Electronics, 1-80 & New Maple Ave., P.O. Box 2003, Pine Brook, NJ 07058; **1-800-846-2484**.

Before you call have the part designator from the PC Board (IC1 in both of the above chassis', but check yours to be sure) and the model number andserial number of your set. These microprocessors have internal ROM and the code is sometimes modified over the life of the product. The microprocessor from an earlier serial number might not work in a later one.

Expect to pay $25-$30 including shipping.

Bob Miller
Trenton, NJ

ANSWER TO #10988 - OCT. 1998

Yes, there is a memory expansion board available for the LaserJet HP II.

There are two types of memory expansion cards, 4 meg and 2 meg that you will have to populate with memory chips. (The 2 meg HP cards can be connected together to make 4 megs. Note: The maximum amount of memory that the HP II will recognize is only 4608K bytes.)

I have found lots of dead laser printers at my local electronics surplus stores, and have been buying them for parts machines.

Unfortunately, I don't have any memory boards left right now. But here are a few places that sell laser printer parts: **Laser Products** Co.,1534 Burlington Ave., Kansas City, MO 64116; phone: **1-800-786-8897**, fax **816-471-1677**. **GOLDSMITH GROUP**, Indianapolis, IN; phone: **1-800-989-7295**, fax **317-545-4883**; E-Mail: recycle@iquest.net, website: www.goldsmithgroup.com

Terry Baker
St. Paul, MN

ANSWER TO #11984 - NOV. 1998

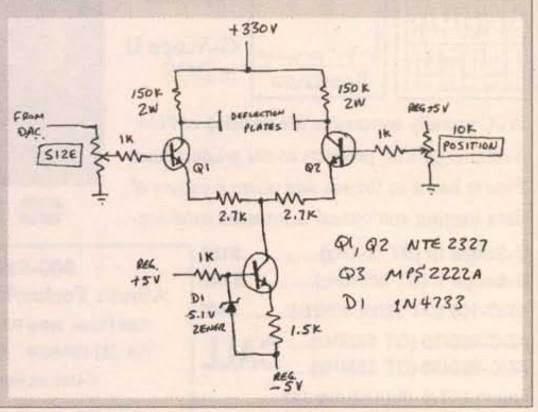
There is no way to prevent duplication of your audio cassette tape, using an electronic gadget or otherwise. In fact, at this point in time, it's easy to dub analog audio cassette tapes, DAT (digital audio tapes), digital mini-discs, and even audio CDs, and also to copy from one format to another.

If your tape can be played back in a standard cassette player, then it's possible to patch the audio from the player into a second deck and make a dub of your original tape. Even if you record the tape at a non-standard speed, requiring the end user to

ANSWERS TO #11985 - NOV. 1998

The 3UP1 is a three-inch CRT with electrostatic deflection. There are two pairs of deflection plates, one for horizontal and one for vertical. The included schematic is for a simple deflection amplifier to drive the plates. You will need two such circuits, one for vertical plates and one for horizontal plates. I am presently using this circuit with a 3RP1 CRT, which has similar electrical characteristics.

The circuit is based on a classic differential amplifier. Q3 forces the sum of the currents through Q1 and Q2 to be constant at 3 milliamperes. The voltage difference between the Q1 and Q2 collectors (applied to the plates) is a function of the difference between the Q1/Q2 base voltages. One base gets the signal input (from the 0-5V DAC output in your case), while the other gets a DC voltage (about 2.5 volts) that positions the undeflected spot in the center of the CRT face. The signal input must be DC-referenced to circuit ground.



If the 3UP1 deflection plate capacitance is indeed 20 picofarads, the effective bandwidth of this amplifier/CRT combination should be at least 50 KHz. My guess is that actual capacitance is lower, so bandwidth will be greater.

For even more bandwidth, you could decrease the emitter/collector resistor values and increase the circuit current.

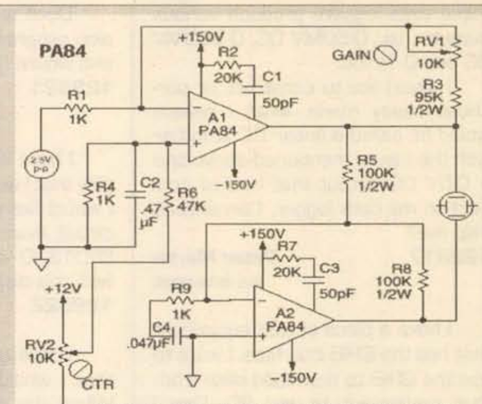
If you cannot obtain sufficient deflection range with this circuit, try increasing the +330 DC supply, making sure that Q1/Q2 have adequate VCC rating.

Joe Moell
Fullerton, CA

ANSWERS TO #11985 - NOV. 1998

Design of a high-voltage deflection drive amplifier with 3 MHz bandwidth is no trivial task. However, there is a device made by Apex Microtechnology that was actually designed for your application.

I am assuming that your CRT uses static deflection because of the low (20 pF) capacitance you quoted. The circuit in the schematic is taken directly from their application notes and uses two PA84 high-voltage power op amps in a bridge configuration. This allows you to use a ±150V power supply to get a ±300V output swing.



ELECTROSTATIC DEFLECTION AMPLIFIER

You could hook a bipolar DAC output directly into the input of the amplifier. A unipolar DAC would require some 0V level shifting. A free data book for Apex Microtechnology devices is available at 1-800-546-2739. If you have Internet access their URL is: http:/www.apexmicrotech.com

Kevin Goodwin
Oceanside, CA

obtain a non-standard player from you, the tape could be duplicated two ways: By connecting the audio output from the special player to the input of a standard recorder, or by playing it on a readily-available variable-speed player.

Consider this drastic — but unrealistic — solution: You load the original non-standard tape on the non-standard player, and weld the player into a steelplate box, with only the controls and speaker accessible, with explosives enclosed to prevent opening the box.

Now, your customer can play the tape, but can't get it out for duplication.

Even so, it would be possible to make a fairly good recording from the loudspeaker in your special player, by using a high-quality microphone, and probably some audio filtering (to compensate for the frequency response of the player's speaker).

So, unless the audio quality needs to be exceptionally good (maybe very high-fidelity music, for example — but audio cassettes aren't capable of high audio quality), someone could make a usable duplicate.

Unauthorized copying is a sore point with the music industry. They lobbied to have circuitry put into DAT decks that prevented making multiple direct-digital copies of digital originals. (This process kept DAT decks off the US market for so long that it effectively killed the demand for them.)

Even so, you can easily connect the analog (audio) output from one DAT deck to the analog input of a second DAT deck, and make all the copies you want.

Depending on how much revenue you stand to lose from unauthorized duplication, you might consider the possibility of copyrighting your material, and prosecuting for any unauthorized duplicates that you discover. I fear though, that you will find this solution fairly impractical.

Greg Miller
State College, PA

ANSWER TO #11986 - NOV. 1998

Many GWBASIC programs (if saved in ASCII format with option A) will run on QBASIC "as-is" complete with line numbers. This is certainly true if your QB version was derived by simply deleting the line numbers from the GWBASIC program. In other words, all of the statements and functions (OPEN, COM, INPUT$, etc.) appearing in your QB version function the same way in both GWBASIC and QBASIC.

How can I make such a claim? By testing your QB version as follows:

First, I connected the COM1: serial ports of my host and remote computers with a null modem cable. Then I wrote, loaded, and ran the following multimeter surrogate program on my remote computer.

```
10 OPEN "COM1:1200,N,7,2,RS,
   CS,DS,CD" FOR RANDOM AS #2
20 IN$ = INPUT$ (1, #2)
30 IF IN$ <> "D" THEN 20
40 PRINT IN$
50 PRINT #2, "-12.34 volt DC"
60 CLOSE #2
```

Next, I loaded and ran (on QBASIC) your QB version on my host computer. The character D was displayed by my remote computer, the string -12.34 Volt DC was displayed by my host computer, thus verifying the fundamental integrity of both programs.

After I added line numbers to

Continued on page 64

HAM GEAR FOR SALE

WANTED: ROCKWELL-Collins HF-80 equipment, 851S-1, 237B-3 log periodic, Collins literature. Jim Stitzinger 805-259-2011, 805-259-3830 (fax), bfl-jfs@smart link.net

HAM EQUIPMENT repair or overhaul Collins, Drake, Swan, Astro, Yaesu, Kenwood, etc. 20 years experience with former Slep Electronics Co. Same excellent service, same reasonable rates, satisfaction guaranteed. Brooks Electronics, 828-349-3503. E-Mail: rwbrooks@ dnet.net

TELETYPE MACHINES. 12 Telex model 32, 1 Telex model 35, 2 Telex model 28, 1 Siemans T100, 1 Telemode 8000, 2 Telemode 1000. Most in working condition. Best offer for the whole works, as-is, where is. Revelstoke BC. Telephone 250-837-2081.

MIKEMASTER: A microphone preamplifier with noise gating & compression. Created by Marv Gonsior W6FR, March 1998 QST. Got noise get MikeMaster! For kit order #210-KIT at $69.95. Assembled & tested (specify Kenwood, ICOM, or Yaesu wiring) order #210-ASY at $89.95. Shipping for US & Canada is $6.50, others add 15%. CA residents add 7.75% sales tax. For info send legal size SASE to A&A Engineering, 2521 W. LaPalma #K, Anaheim, CA 92801. P 714-952-2114, Fax 714-952-3280.

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

THE SMART BATTERY CHARGER for lead acid or gel cell batteries. Can be left connected to the battery **INDEFINITELY**, will not overcharge! Standard kit is 12V @ 1 amp. This kit is 100% complete. For the kit order #150-KIT at $59.95. For an assembled and tested unit, order #150-ASY at $79.95. CA residents add 7.75% sales tax. Add $6.50 per unit shipping. MC/VISA accepted. A&A Engineering, 2521 W. La Palma #K, Anaheim, CA 92801. 714-952-2114, FAX 714-952-3280.

LML RADIO 2 meter mobile amp by Motorola 60 watt $30; Motorola Mostar VHF 16 ch. prg. 45W $30; MT500 50MHz $35; Syntor VHF 45W prg. UHF repeater 15W programmable 256 channels $120. Free catalog 909-873-1319. Fax on demand 24 hr. 909-820-1885. Web catalog. http://members.aol.com/hrh6/LMLinc Write 424 E. Shamrock, Rialto, CA 92376.

POWER SUPPLIES Pyramid, simply the best durable power supply on the market for value! Ideal for radio use, amps, or bench work. 13.8 VDC from 3 amps to 52 amps available with surge protection. Some models available with cigarette plug socket. Factory packed in retail display boxes. All come factory new with one year warranty. Lowest prices on any quantity. Wholesale/distributors welcome. Gentry Communications 507-332-2788.

SPECTRUM ANALYZERS, test equipment. Closing R&D/manufacturing company. Must sell lots of equipment. Call 1-800-869-7827 or visit www.starcom.com

NEW PRODUCTS FROM S & S: UPGRADE YOUR OLD RIGS! Digital dial (counter) has 10Hz resolution **HF**, 100Hz **VHF** and frequency range 50KHz to 230MHz; kit $99.95; assembled $149.95. **NEW Digital VFO** with 1Hz resolution to 54MHz; kit $169.95; assembled $219.95. S&H $7 (Continental US). **GUARANTEED TO WORK.** For info send **SASE.** Call/write to order: S & S Engineering, 14102 Brown Rd., Smithsburg, MD 21783. 301-416-0661, E-Mail: N3SAD@aol.com or see http://www.xmetric.com/sseng

HAM GEAR WANTED

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

CB – SCANNERS

SALES, SERVICE: CB equipment, radios, modifications, power mice, echo-reverb boxes, kits, meters, filters, antennas, noise toys, mounts, hard-to-find items. Partial list $1, complete list $4. D&R Electronics, 10 Park St., Thomaston, CT 06787. 860-283-9492.

RED BOOK CB MODIFICATION. Audio, modulation, PLL/VCO, sliders, $25. Ken's 2825 Lake, Kalamazoo, MI 49001. 616-345-4609. www.kenselec tronics.com

BLACK BOOK CB LINEARS. Theory, 60 schematics. $25. KEN's, 2825 Lake, Kalamazoo, MI 49001 616-345-4609. www.kenselectronics.com

ULTIMATE MODIFICATION BIBLE. Mind boggling is the only way to describe this 220 page book. Modification of CBs, channels, power, sliders, talk back and more. 10 meter radios, HAM RADIO, scanners, toys, meters, and more. Only $29.95 + $3.25 shipping. Phone orders 1-800-256-9895 (MC-Disc-Visa) No CODs.

ORANGE BOOK SCANNER REPAIR. 500 models, modifications, $25. KEN's, 2825 Lake, Kalamazoo, MI 49001 616-345-4609. www.kenselectronics.com

SCANNING USA: monthly magazine 100% scanning. All the news and product reviews from the writers you trust. Get more from your scanner. Subscriptions $24.95, samples $3. Call 1-800-651-0922 your Visa or MasterCard, or write 2054 Hawthorne, Joliet, IL 60435

"CB MODIFICATION SECRETS," new 200-page guide by author of "CB Radio Hacker's Guide." More easy AM/SSB CB upgrades & enhancements: Cobra, Realistic, Uniden, President, etc. Freq. expansion, VFO, clarifier unlock, VOX, Roger Beep, anti-theft device, receive preamp, more. Only $21.95, plus $5 S/H ($7 to Canada). CRB Research, Box 56, Commack, NY 11725. NYS res. add $2.22 tax. Visa/MC orders call: 516-543-9169.

CB RADIO EQUIPMENT: Selling all kinds of equipment! For details E-Mail: **rushead1@juno.com**

CB MODIFICATIONS! Frequencies, books, kits, high-performance accessories, plans, repairs, amplifiers, 10-meter conversions. The best since 1976! Catalog $3. CBCI, Box 1898NV, Monterey, CA 93942. www.cbcintl.com

240+ CHANNEL CB/HAM/COMMERCIAL radios: AM/FM/SSB/CW export/domestic: RCI, Motorola, Uniden, Cobra, Alinco, Kenwood. Mics, antennas, linears, meters, books, night scopes, and tons more stuff! Catalog $3. MAXTECH, Box 8086, New York, NY 10150. 718-547-8244.

KONNEX DISTRIBUTING. Call 1-888-777-7874. PO Box 451372, Los Angeles, CA 90045. CBs, antennas, meters, transistors. Best prices. Credit card acceptable.

ANTTRON 101 CB 10 METER base station antenna with isolation network, no bleedover, no splatter, no TVI tuning sleeve technology 3 piece fiberglass $69.99. **Twin-Tronics, Inc.** PO Box 2571, Youngstown, OH 44507-0571. Send $1 for literature, refundable. Ph 330-788-9693. Fax 330-788-7709.

ROGER BEEP noise toys with instructions. Send $18 each postage paid to: TINKERTRONICS, PO Box 270786, Corpus Christi, TX 78427.

SUPERSTAR, GALAXY, Mirage, Uniden, Cobra, microphones, power supplies, scanners hard-to-find products, picture price sheets. $1 to cover postage (REFUNDABLE). Galaxy, Box 1202, Akron, OH 44309. Over 10 yrs. in business.

MUSIC & ACCESSORIES

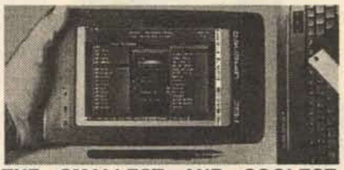
Subscribe to Nuts & Volts Today!
Call 1-800-783-4624
and Use Your Visa or MasterCard.

COMPUTER HARDWARE

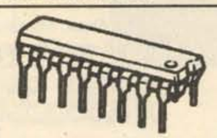
START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

WE CARRY a variety of cables, switch boxes, accessories, and adapters to connect PCs, printers, Mac's, networks, telecommunications, and audio/video equipment. We offer: custom cables, free catalogs, and same day shipping on most orders. Visit our website at www.rogerssystems.com or call 1-800-366-0579.

CRTs CHEAP. Buy direct from the manufacturer. Save money. Mfg. all CRT types since 1950. **3 year warranty**. Reg-Res 19" tubes $75; 25" $100; hi-res 13" tubes from $80. We specialize in **hi-resolution** video/computer CRTs. **T.M.C.** 215-226-0749/215-223-0388.



THE SMALLEST AND COOLEST, FULL IBM PC EVER MADE! Yours for $649! Cost was $4,000. People are amazed when they see it! Extremely well made. Weighs only 2 pounds! Measures 9"x5.5"x1.37"! Take it wherever you go! Runs any application for DOS or Windows 3.1. Windows for pen computing has animated icons & sound annotation with a cool female personality. Only a few available, so don't wait a single day. Built-in handwriting recognition and on-screen or external keyboard. Electronic pen acts as a mouse and doesn't need to touch the glass screen to move the cursor! 486/25 with 4 meg RAM and 80 megabyte capacity. Razor sharp 6" mono screen 640x480/1 meg VGA touch screen, built-in speaker, parallel/serial/ext. monitor, outputs. Includes: electronic pen, battery, glove leather case, AC supply, compact external keyboard is the same size as the computer. Small external half inch high 1.4 floppy. Books and software. Netcom 1-800-733-3733 ext. 6300.



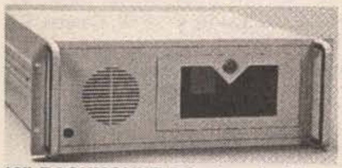
WANTED: EXCESS ELECTRONIC INVENTORIES, ICs, MEMORY, EPROMs, PALs, LEDs, CIRCUIT BOARDS, DIODES, AND TRANSISTORS. CALL ACTIVE MICRO, 435-867-8660 OR FAX 435-867-8663.

http://www.pccables.com PC CABLES and PARTS. 100s of hard-to-find new cables and parts, free technical information, low prices, fast online ordering & browsing.

COLOR LASER PRINTERS: Hewlett Packard Color Laserjet (3100A) $1,490; QMS Colorscript 210 (postscript) $995; QMS Colorscript 230 (postscript) $1,395; QMS Magicolor CS1000 (11x17") $1,695; Tektronix Phaser (4693PX) $595; Tektronix Phaser 200I (postscript) $895; Tektronix Phaser III PXI (11x17") $995; Tektronix Phaser 300I (11x17") $1,695. Accept VISA, MasterCard, AMEX. 60 day warranty. Call MAPLE DATA: 908-964-7070. E-Mail: Maplesales@aol.com

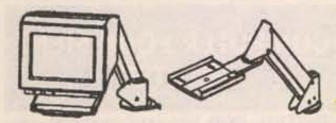
Write In 59 on Reader Service Card.

PENTIUM MOTHERBOARDS, VIA chipset, 1MB, AGP, 100MHz operation, 3 ISA/3 PCI, $95. **CPUs:** Celeron 128K 300/333 @ $169/179. Pentium **II:** 300/333/350/400/450 @ $239/259/279/419/599; **/IBM/Cyrix** 233/266/300/333 @ $66/78/99/149; **AMD K6 MMX** with 3D Now 266/300/333/350 @ 109/119/129/169. 36X **CD-ROM,** audio button $44, 32/64MB SDRAM 10ns DIMM $49/99, 64/128MB PC-100 DIMM $101/199. S3 Trio 3D 4MB AGP video card $34. Call for current pricing, other parts and illustrated catalog, faxback catalog pages, 1-year warranty or better. tech-specialities, Inc., 5703 Heffernan, Houston, TX 77087-4113, 1-800-864-5391 for orders and tech support, fax: 713-307-0314, Internet: www.ts.nu



19" RACKMOUNT PC chassis: Heavy duty, 4U, for standard 7 slots ATX motherboard. Optional 8, 12, 14 slots back panels available. Four (three hidden) 3.5"/two 5.25" drive bays, 4.625" front panel fan, power supply not included, $189 with this ad! Monitor chassis $269, keyboard chassis $139. 8255-8253 I/O card with prototyping area $69, 12-bit ADDA card $89. **Computronics Technology,** 972-242-8087.

SYSTEMS, PERIPHERALS. UPS. Closing R&D/manufacturing company. Must sell lots of equipment. Call for list 1-800-869-7827 or visit www.starcom.com for list



MONITORS R US©, COLOR $54 & UP, used, low milage, refurbished, run in 5 hrs. & calibrated. Excellent image, 90 day warranty. Satisfaction guaranteed. **(1) 14" VGA .28DP, analog controls $49 ea.** Your choice Phillips-Magnavox, Teco, Hyundai, CTX & Unisy brands. **(2) 14" VGA .26DP digital controls $69 ea.** Maker Zenith Data Systems. **(3) ERGO MONITOR ARM SET , NEW IN FACTORY SEALED CARTON NOW $59 ea.,** includes MA-2 arm, CM desktop clamp and monitor tray. **(4) NEC-AST VERSA, Laptop Docking Station Series 2, $49 each.** New in factory sealed carton. **(5) MICRO FERRUPS MODEL ME-3.1 KVA, MAKE OFFER.** Shipping weight about 200 lbs. **NOTE:** all prices each, FOB Las Vegas. UPS shipping weight 14" monitors 30 lbs., monitor arm set 36 lbs. & docking station 28 lbs. Mail orders: **LESS BUSTERS ELECTRONICS, 2039** CIVIC CENTER DRIVE #176, N. LAS VEGAS, NV 89030, 702-642-0325. **WEB www.lessbusters.com**

BUILD YOUR own PENTIUM COMPUTER from parts with the help of an easy to view 80 min video tape. This award winning VHS tape shows how to save money or even start a small business by assembling any IBM compatible 386 to Pentium II computer in a step-by-step, easy-to-follow procedure. Don't let this opportunity pass you by! Order today, while supplies last, only $29 (reg. $59.95) plus $2.95 P&H. Send check to: **EVP, PO Box 2201, Northlake, IL 60164-0201** or call **1-800-754-5096** now!

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.,** 937-847-2300 OR fax 937-847-2350.

UTWE KNOWS what YOU want on the web! Pictures of the private parts collection of UTWE (yea, and cheap prices). See all those SCSI cases, the mainboards, the network cards, the disk drive controllers, video cards, network hubs, cables (you did realize I meant computer parts right?), keyboards, drives, sound cards, and some other new and used oddball stuff by stopping by www.utwe.com If you just want text deal sheets sent to you then E-Mail: deal sheets@utwe.com And of course, we still have a voice phone 626-930-1121 (10am-5pm PST) and fax 626-930-1123. E-Mail: sales@utwe.com

4 MB, 72 Pin SIMMs $4 ea. Pikul & Associates, 314-937-0335.

MONITOR ADAPTERS. Convert OEM. (incl. PGA) 31.5KHz & above monitors with BNC connectors to PC use. Model VA10 VGA to RGB+ Sync $45. Model VA11 VGA to R G/Sync B $55. VA12 VGA to PGA (DB9) $45. Pikul & Assoc., 101 Glenfield Dr., Festus, MO 63028. 314-937-0335.

EVERYTHING NEW w/warranty! P300MHz MMX $195, 1.28 gigabyte HD $65. 15"/17" SVGA monitors $145/235. Pentium Class systems from $350. Also multimedia kits, hard drives, scanners, printers, SCSI adapters $25. Memory, cases, etc. Call for monthly specials. CCI 714-778-0450. E-Mail: cci@net999.com

P233 MHz Multimedia systems, fully loaded, liquidation price $495. Laser printers $175, color Inkjets $95, Notebooks $350, closeout prices on software. Call 714-778-0450.

CNC SYSTEMS! Write: motivity, Attn. Pam, PO Box 428, Rocklin, CA 95677. Call: 916-349-8757. Info/pictures at **www.motivityusa.com** A great place to buy CNC.

HARD DRIVE liquidation 1,280 megabytes $65. 2,100 MEG $85. Mouse $1.95, SVGA monitors $135, flatbed scanners $75, 56K modems 45, 386SX40 $25, 1.2/1.44 floppy $20, Adaptec SCSI controllers $45, memory 1.25/megabyte. 714-778-0450.

SONY/AMIGA/MAC/IND. MULTISCANS 15" 0.26 DP 15.7-37KHz TTL/Analog, sync on green, &150 **Blem 15" SVSA's $85.** Expert Sony repair.Refurbished. Pikul & Assoc., 101 Glenfield Dr., Festus, MO 63028. 314-937-0335.

CD DUPLICATOR MediaFORM Genesis 2601. Duplicate or master up to 25 CDs at a time. Accepts most CD formats. $4,200 or best offer. GearHead Electronics, PO Box 413, Williamsville, NY 14231-0413, 716-636-4370, http://www2.pcom.net/gearhead

LOOKING FOR cheap clone PC parts that actually work? Call UTWE for CD-ROMs, hard drives, disk controllers, video cards, mainboards CPUs, etc. For example, NEW Clone-o-matic mainboard with 4 PCI, 3 ISA, 256K cache, I/O built on board with 200MHz AMD $100, 2 meg PCI S3 video board $20. 486 "all in one" mainboard (video and IDE IO) $35 ea. Remember, today we have, tomorrow we don't! For all the latest deal sheets E-Mail: dealsheets@utwe.com Call 626-930-1121 (10am-5pm Pacific) or fax 626-930-1123. E-Mail: sales@utwe.com

Closing Date For Next Issue – December 5th!

SVGA MONITOR, $60; 486 computer with SVGA monitor, $125; 15" SVGA monitor, $100, HP plotter 7475, $50; HP plotter 7550A, $75; Macintosh monitor, $50, Macintosh powerbook 140, 230, $150. Much more call 714-827-7345

COMPUTER SOFTWARE

FREE IBM DISK CATALOG of quality Shareware and CD-ROMs. **MOM 'N' POP'S SOFTWARE** <ASP>, PO Box 15003-N, Springhill, FL 34609-0111. 352-688-9108. momnpop@gate.net

LINUX & FREEBSD & LINUX & FREEBSD Linux and FreeBSD distributions on CD-ROM for as low as $1.99. See our full range of Linux products and books at **incredible prices.** Use our secured shopping cart system at **www.cheapbytes.com** Visa and MasterCard gladly accepted. E-Mail: sales@cheapbytes.com fax: 209-367-8518. CheapBytes, PO Box 2714, Lodi, CA 95241.

MOD CHIPS for Sony PlayStation. Now your backups will work. Only $9.95 ea. + $3 shipping. Call 1-888-467-6150, all major credit cards accepted. Computers & components at wholesale prices. www.cconusa.com

MAKE $$$ giving away our software! Business kit $10 (refundable). RASCOM, 860 E. Carson St. #118-89, Carson, CA 90745.

CAM & MOTION SW/HW: Z-trace, PCB toolpath. Plotcam motion control, step drivers. cmheater@juno.com MSG/FAX 407-452-7197, 407-459-2729. **www.megabits.net/ddt**

LIQUIDATION WIN 95/98, Office97, WindowsNT, 10 PACK CDs $25, DOS $25, Lotus Smartsuite $10, Wordperfect Suite $35. Antivirus $5. Call 714-778-0450.

MICROSOFT OFFICE 97 PROFESSIONAL EDITION, $79. That's right, $79. Includes Word 97, Excel 97, Access 97, PowerPoint 97, and Outlook 97. Brand new, unopened, and shrink-wrapped. Easy fulfillment. No manuals. Visa/MC accepted. Call Gulf Professional Services toll-free 1-888-208-9797, or order online at www.gulfpro.com E-Mail: sales@gulfpro.com

COMPUTER EQUIPMENT WANTED

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

HP CALCULATORS wanted: models 10, 70, calculator watch, others for private collection. Cash paid. Bob Morrow, 765-855-2348, rkmorrow@aol.com

WANTED: TERMINALS + PRINTERS: DEC, Wyse, IBM, ADDS, Okidata, Data South, Epson, C.ITOH, etc. Call for quote on any surplus computer equipment. Call Jeremy, 603-673-8077.

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.,** 937-847-2300 OR fax 937-847-2350.

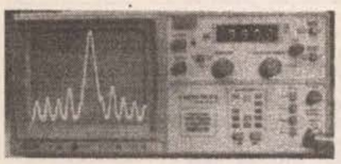
WANTED: IBM System 23 monitor model #5324. Working or not, but complete. Will pay shipping. Dick Lotz, 3282 Zoeller Rd., Alden, NY 14004.

TEST EQUIPMENT

SUCH A DEAL! Check out Metric's "Current Specials" at **http://www.metricsales.com** Great deals on top quality reconditioned test equipment. Call 1-800-432-3424 for a free catalog.

FEITEK PROVIDES repair, calibration and traceable certifications of test equipment. Free estimates. We buy, sell and trade all makes of test equipment. Visa and MasterCard accepted. Check out our inventory and specials at WWW.FEITEK.COM 2752 Walton Road, St. Louis, MO 63114, 314-423-1770.

TEST EQUIPMENT: HP 3590A wave analyzer + 3593A sweeping local oscillator $500, HP 3702B IF/BB receiver + 3705A diff phase detector $500, HP 5327B timer counter DVM $350, HP 6131C digital voltage source 100V .5 amp $375, HP 3760A data generator $275, HP 3490A multimeter $400, Nicolet digital oscilloscope 20903C + 204A plug-in $595, Philips PM664A 520MHz counter $200, Marconi TF791D carrier deviation meter $200, Marconi TF1066B FM signal generator $250, Marconi TF2300 FM/AM modulation meter $350, Fluke 633A frequency synthesizer $325, Eldorado Electronics 796 time interval counter $175, Berkeley 6401A programmable counter timer $200, Federal Scientific UA500 ubiquitous spectrum analyzer $400, Rotek 146A absolute AC voltage standard $275, LCI pipe laser PL120 with remote $1,850. BURTON EQUIPMENT 513-897-1596. Fax 513-897-3837.



ENGINEER TESTED: Spectrum analyzers, frequency counters, frequency standards, meters, scopes, generators, curve tracers, temperature, time, weight, light, sound, distance, etc., measurement instruments. **VISA, MASTERCARD, AMEX.** "Performance tested." **NIST** calibrated. Warranteed. **New & used.** Gary N6ZD. **HTTP://TECH-SERVICES.COM**

ENI MRI 2000 2KW linear pulse power amp 15-65MHz, unused, $1,600; National Bureau of Standards, variable rejection filters for the following frequencies: 220-440KHz, 1.75-3.5MHz, 55-110KHz, 27.5-55KHz, 110-220KHz, 440-880KHz, $200 ea.; GR 1606A, RF bridge, $400; RF communications 805, RF amp 50KHz-80MHz, 47dB, 7W PO, $450; Tektronix 2235 100MHz scope, $600; HP 1727A, 275MHz storage scope, $650; HP 1712A, 200MHz scope, $500; Tek TM504, $150; DM 501A, $200; FG503 3MHz function gen., $200; PS503A, $150; HP 3406A, RF voltmeter, $400; Boonton 42B, RF voltmeter, $250; HP 3490A, 5.5 dig DVM, $300. A-Comm Electronics 303-341-2283.

TERRIFIC VALUES: HP 54100D 1GHz digitizing oscilloscope $3,100; **Tek AM 503, A6302** current probe, amplifier $825; **HP 83522A** .01 to 2.4GHz plug-in $3,900; **HP 83570A** 18 to 26.5GHz plug-in $4,900; **HP 3488A** mainframe $650 (cards available); **HP 8161A/020** 100MHz dual channel pulse generator $2,750; **Stanford Research SR 510** lock-in amplifier $975; **HP 8410C, 8410B, 8410A** network analyzer mainframes $625, 450, 250; **HP 8411A/018, 8411A** harmonic frequency converters $395, 295; **HP 8743B/018, 8743A** test sets $575, 325. All in excellent condition with warranty. Pepper Systems (http://home.earthlink.net/~peppersys) 214-353-0257 (Fax 214-902-9511). E-Mail: peppersys@earthlink.net

KENTRONIX TEST EQUIPMENT SPECIALS. Check our WEB site at **http://www.kentronix.com** for monthly specials. We are also looking to buy test equipment, coaxial and waveguide components, manuals, etc. Contact Brian at 732-681-3229 or FAX 732-681-3312. E-Mail: brian@kentronix.com

WANTED: RADIO service monitors, IFR, Motorola, HP, Marconi, also late model HP equipment. 716-763-9104 or Fax 716-763-0371. http://www.amtronix.com

TEST EQUIPMENT repair or overhaul Tektronix, HP, Wavetek, Boonton, etc. 20 years experience with former Slep Electronics Co., same excellent service same reasonable rates, satisfaction guaranteed. Brooks Electronics 828-349-3503. E-Mail: rwbrooks@dnet.net

NEW HEWLETT-PACKARD 141T CRTs $195 EACH. We have quantities available. These are double boxed, unopened with late 80's date code, guaranteed. Fits all Kentronix. 732-681-3229 or FAX 732-681-3312. Mailing: Kentronix, PO Box 2444, Farmingdale, NJ 07727 or E-Mail: brian@kentronix.com

EQUIPMENT MANUALS we have 1000's of service and operators manuals for all types of test and measurement equipment from 1950 to present. All test equipment manufacturers are represented. Call, write, or fax your want list. Please include mfg.'s manual P/N unit serial numbers if known. **Manuals Plus**, Box 549, TAD #601, Tooele, UT 84074. 435-882-7188, FAX 435-882-7195.

AFFORDABLE HP power sensor repair! Most 8481As repaired for $235 or less. We also handle 478As and many others. Call or fax for more information. Willamette RF, Inc., 541-754-7226, FAX 541-753-4629.

MICRODYNE 1100, 1200, 1400 series receivers all bands, FM and PM demods, SDU, IF filters. Aydin, Schlumberger, monitor systems bit syncs. 805-934-2058.

WANTED! ELECTRONIC test equipment. We pay top dollar for used scopes, generators, analyzers from HP, Tektronix, and others. Call Charles at Metric for immediate quotation. **1-800-432-3424** Fax: 510-264-0886.

WANTED: WESTERN electric test equipment. Tube-type only please. Freq. measuring sets, oscillators, amplifiers, parts, tubes, etc. 1-800-251-5454.

BRUEL & KJAER BUY, SELL, BEST PRICES. EXCALIBUR ENGINEERING, 3198-C AIRPORT LOOP DRIVE, COSTA MESA, CA 92626. 714-540-0169, FAX 714-540-5417.

EQUIPMENT SALE: HP 8564, $350; HP 59501A D/A power supply $50; HP 1630G logic analyzer, with all pods $450; 1630D, $300; Anritsu 645A, both the sending & receiving unit for $250; Leader LPS-151 DC tracking supply $200. Psitech Plus 707-745-4804, SEE www.psitech-plus.com for more.

RAMSEY

World's Smallest TV Transmitters

We call them the 'Cubes'.... Perfect video transmission from a transmitter you can hide under a quarter and only as thick as a stack of four pennies- that's a nickel in the picture!

Transmits color or B&W with fantastic quality - almost like a direct wired connection to any TV tuned to cable channel 59. Crystal controlled for no frequency drift with performance that equals law enforcement models that cost hundreds more! Basic 20 mW model transmits up to 300' while the high power 100 mW unit goes up to 1/4 mile. Audio units include sound using a sensitive built-in mike that will hear a whisper 15 feet away! Units run on 9 volts and hook-up to most any CCD camera. Any of our cameras have been tested to mate perfectly with our Cubes and work great. Fully assembled - just hook-up power and you're on the air!

C-2000, Basic Video Transmitter Cube....$89.95
C-3000, Basic Video and Audio Transmitter Cube....$149.95
C-2001, High Power Video Transmitter Cube....$179.95
C-3001, High Power Video and Audio Transmitter Cube....$229.95

Super Pro FM Stereo Radio Transmitter

A truly professional frequency synthesized FM Stereo transmitter station in one easy to use, handsome cabinet. Most radio stations require a whole equipment rack to hold all the features we've packed into the FM-100. Set frequency easily with the Up/Down freq buttons and the big LED digital display. Plus there's input low pass filtering that gives great sound no matter what the source (no more squeals or swishing sounds from cheap CD player inputs!) Peak limiters for maximum 'punch' in your audio - without over modulation, LED bargraph meters for easy setting of audio levels and a built-in mixer with mike and line level inputs. Churches, drive-ins, schools and colleges find the FM-100 to be the answer to their transmitting needs, you will too. No one offers all these features at this price! Kit includes cabinet, whip antenna and 120 VAC supply.

We also offer a high power export version of the FM-100 that's fully assembled with one watt of RF power, for miles of program coverage. The export version can only be shipped outside the USA, or within the US if accompanied by a signed statement that the unit will be exported.

FM-100, Professional FM Stereo Transmitter Kit....$299.95
FM-100WT, Fully Wired High Power FM Transmitter....$429.95

AM Band Radio Transmitter

Ramsey AM radio transmitters operate in the standard AM broadcast band and are easily set to any clear channel in your area. Our AM-25, 'pro' version, fully synthesized transmitter features easy frequency setting DIP switches for stable, no-drift frequency control, while being jumper setable for higher power output where regulations allow. The entry-level AM-1 uses a tunable transmit oscillator and runs the maximum 100 milliwatts of power. No FCC license is required, expected range is up to 1/4 mile depending upon antenna and conditions. Transmitters accept standard line-level inputs from tape decks, CD players or mike mixers, and run on 12 volts DC. The Pro AM-25 comes complete with AC power adapter, matching case set and bottom loaded wire antenna. Our entry-level AM-1 has an available matching case and knob set for a finished, professional look.

AM-25, Professional AM Transmitter Kit....$129.95
AM-1, Entry level AM Radio Transmitter Kit....$29.95
CAM, Matching Case Set for AM-1....$14.95

CCD Video Cameras

If you're looking for a good quality CCD board camera, stop right here! Our cameras use top quality Japanese Class 'A' CCD arrays with over 440 line line resolution, not the off-spec arrays that are found on many other cameras. You see, the Japanese suppliers grade the CCDs at manufacture and some manufacturers end up with the off-grade chips due to either cost constraints or lack of buying 'clout'. Also, a new strain of CMOS single chip cameras are entering the market, those units have about 1/2 the resolution and draw over twice the current that these cameras do - don't be fooled! Our cameras have nice clean fields and excellent light sensitivity, you'll really see the difference, and if you want to see in the dark, the black & white models are super IR (Infra-Red) sensitive. Our IR-1 Illuminator kit is invisible to the human eye, but lights the scene like a flashlight at night! Color camera has Auto White Balance, Auto Gain, Back Light Compensation and DSP! Available with Wide-angle (80º) or super slim Pin-hole style lens. They run on 9 VDC and produce standard 1 volt p-p video. Add one of our transmitter units for wireless transmission to any TV set, or add our IB-1 Interface board for audio sound pick-up and super easy direct wire hook-up connection to any Video monitor, VCR or TV with video/audio input jacks. Cameras fully assembled, including pre-wired connector.

CCDWA-2, B&W CCD Camera, wide-angle lens....$99.95
CCDPH-2, B&W CCD Camera, slim fit pin-hole len....$99.95
CCDPH-2, Color CCD Camera, wide-angle lens....$149.95
IR-1, IR Illuminator Kit for B&W cameras....$24.95
IB-1, Interface Board Kit....$24.95

FM Stereo Radio Transmitters

Microprocessor controlled for easy frequency programming using DIP switches, no drift, your signal is rock solid all the time - just like the commercial stations. Audio quality is excellent, connect to the line output of any CD player, tape deck or mike mixer and you're on-the-air. Foreign buyers will appreciate the high power output capability of the FM-25; many Caribbean folks use a single FM-25 to cover the whole island! New, improved, clean and hum-free runs on either 12 VDC or 120 VAC. Kit comes complete with case set, whip antenna, 120 VAC power adapter - easy one evening assembly.

FM-25, Synthesized FM Stereo Transmitter Kit....$129.95

A lower cost alternative to our high performance transmitters. Offers great value, tunable over the 88-108 MHz FM broadcast band, plenty of power and our manual goes into great detail outlining aspects of antennas, transmitting range and the FCC rules and regulations. Connects to any cassette deck, CD player or mixer and you're on-the-air, you'll be amazed at the exceptional audio quality! Runs on internal 9V battery or external power from 5 to 15 VDC. Add our matching case and whip antenna set for a nice finished look.

FM-10A, Tunable FM Stereo Transmitter Kit....$34.95
CFM, Matching Case and Antenna Set....$14.95
AC12-5, 12 Volt DC Wall Plug Adapter....$9.95

RF Power Booster

Add some serious muscle to your signal, boost power up to 1 watt over a frequency range of 100 KHz to over 1000 MHz! Use as a lab amp for signal generators, plus many foreign users employ the LPA-1 to boost the power of their FM Stereo transmitters, providing radio service through an entire town. Runs on 12 VDC. For a neat, professionally finished look, add the optional matching case set.

LPA-1, Power Booster Amplifier Kit....$39.95
CLPA, Matching Case Set for LPA-1 Kit....$14.95
LPA-1WT, Fully Wired LPA-1 with Case....$99.95

Treasure Finder Kit

Search for buried treasure at the beach, backyard or park. This professional quality kit can detect metal at a depth of up to 6 inches. Easy to use, just listen for the change in tone as you 'sweep' the unit across the surface - the larger the tone change - the larger the object. Has built-in speaker or earphone connection, runs on standard 9 volt battery. Complete kit includes handsome case, rugged PVC handle assembly that 'breaks down' for easy transportation and shielded Faraday search coil. Easy one evening assembly. This nifty kit will literally pay for itself! That guy in the picture looks like he found something - what do you think it is - gold, silver, Rogaine, Viagra? You'll have fun with this kit.

TF-1, Treasure Finder Kit....$39.95

Binocular Special

We came across these nice binoculars in an importers close-out deal. Not some cheap in-line lens jobs, these beauties have roof prisms, a super nice rubber armored housing over light weight aluminum. 10 x 25 power with fully coated optics. Includes lens cleaner cloth, neck lanyard and nice carry case. For extra demanding use in bright sun, choose the EX module with ruby coated Objective lens. First quality at a close-out price! We've seen the exact same units with the 'Bushnell' name on them being sold for $30 more!

BNO-1, Binoculars and case....$24.95
BNO-1EX, Ruby Coated Lens Binoculars and case....$29.95

Speech Descrambler

Decode all that gibberish! This is the popular descrambler / scrambler that you've read about in all the Scanner and Electronic magazines. Speech inversion technology is used, which is compatible with most cordless phones and many police department systems, hook it up to your scanner speaker terminals and you're in business. Easily configured for any use: mike, line level and speaker output/inputs are provided. Also communicate in total privacy over telephone or radio, full duplex operation - scramble and unscramble at the same time. Easy to build, all complex circuitry contained in new custom ASIC chip for clear, clean audio. Runs on 9 to 15VDC. Our matching case set adds a professional look to your kit.

SS-70A, Speech Descrambler/Scrambler Kit....$39.95
CSS, Custom Matching Case and Knob Set....$14.95
SS-70AWT, Fully Wired SS-70A with Case....$79.95
AC12-5, 12 Volt DC Wall Plug Adapter....$9.95

Call for our Free Catalog !

See our complete catalog and order on-line with our secure server at:
www.ramseyelectronics.com

RAMSEY ELECTRONICS, INC.
793 Canning Parkway Victor, NY 14564

Order Toll-free: 800-446-2295
Sorry, no tech info, order status at this number

Technical Info, Order Status
Call Factory direct: 716-924-4560
Fax: 716-924-4555

VISA MasterCard DISCOVER

ORDERING INFO: Satisfaction Guaranteed. Examine for 10 days, if not pleased, return in original form for refund. Add $6.95 for shipping, handling and insurance. Orders under $20, add $3.00. NY residents add 7% sales tax. Sorry, no CODs. Foreign orders, add 20% for surface mail or use credit card and specify shipping method.

Write in 62 on Reader Service Card.

CAPANALYZER 88 finds bad caps in-circuit with 100% accuracy. Checks both ESR and DCR, auto-discharge feature. Money back guarantee. www.eds-inc.com 561-487-6103.

LEAKSEEKER 82A tracks a shorted or leaky component to the EXACT location on the PCB. Range: zero to 150 ohms. Money back guarantee. www.eds-inc.com 561-487-6103.

WANTED: ELECTRONIC estates. Ham, broadcasting, military, test, public address, tubes, transformers, telex equipment. The bigger the pile, the more worthwhile. We fly anywhere. Sumner McDanel 1-800-251-5454.

BEST PRICES on guaranteed test equipment. Oscilloscopes, Tektronix 305, 454, 475, SC 504, 2225, 2246, & others. Huntron Tracker 2000, Fluke, HP and other fine used test equipment. Check us out at: **www.lonemtn.com**

SPECTRUM ANALYZER in a probe. $249. View thru your inexpensive scope. WWW.spectrumprobe.com

LOWEST PRICES! Check out Metric's "Current Specials" at **http://www.metricsales.com** Great deals on top quality refurbished test equipment. Call 1-800-432-3424 for a free catalog.

WANTED! ELECTRONIC test equipment. We pay top dollar for used scopes, generators, analyzers from HP, Tektronix, and others. Call Charles at Metric for immediate quotation. **1-800-432-3424** Fax: 510-264-0886.

WANTED! ELECTRONIC test equipment. We pay top dollar for used scopes, generators, analyzers from HP, Tektronix, and others. Call Charles at Metric for immediate quotation. **1-800-432-3424** Fax: 510-264-0886.

WE BUY electrical power systems test equipment. This includes the following manufacturers: **Multi-Amp** (now AVO Multi-Amp), **Biddle** or James G. Biddle (now AVO Biddle), **Megger** (now AVO Megger), **Associated Research, AEMC, EIL, Programma** or any other test equipment used for testing high voltage equipment and components. The test equipment that we are looking for is used for testing high voltage transformers, circuit breakers, cables, and protective relays. FAX 972-564-9139 or phone 1-800-261-9139 for quote. **Phase-3 Power Test Equipment.**

POOR MAN'S Spectrum Analyzer/Monitor Receiver Kit. 2 to 1,700 MHz. Basic kit only $78. Now available with switched resolution filters, tracking generator and direct digital frequency readout. Works with ANY scope or IBM compatible computer. Send stamped envelope for details. Science Workshop, Box 310B, Bethpage, NY 11714. http://www.science-workshop.com

CUSHMAN CE3 $175; Heathkit frequency counter SM2420 0-512MHz $29; Tek 191 sig-gen $100; Tek 465 & DM 40 $125. Call for list. 909-873-1319.

DIGITAL, ANALOG, & RF test equipment. Closing R&D/manufacturing company. Must sell lots of equipment. Call 1-800-869-7827 or visit www.starcom.com for list.

SCOPE SALE: 475A DM44 $500. 453 man, cover as new $175, 465 $175; 5223 as new $200; Philips PM3217, $200; Kikisui 50MHz 4 channel 5042, $200; Tek 466, $300; 7A13, $100 LED; 7A18, $45; 7A19, $100; 7A26, $60; 7B53A, $60; 7B80/7B85, $75 ea.; 7B92A, $125; 7D15, $175; DC504, $100; FG-504, $350; PG-508, $350; S-2 sampling head $150; SC-502 Scope $200; SI-5010 as new $200. CALL FOR OTHERS, all with 30 day warranty. Call **Psitech Plus** phone 707-745-4804. SEE www.psitech-plus.com for more.

FACTORY BOXED new 30 HSM 2GHz high-speed module $450; Fluke 8921A True RMS voltmeter, $300. Psitech Plus, 707-745-4804, fax 707-747-5277. SEE www.psitech-plus.com for more.

NEW: POCKET TESTBENCH, tiny, portable, RS-232 instrument. Scope, logic, spectrum, counter, generator modes. Oricom Technologies, 303-449-6428 (www.sni.net/~oricom).

DEC EQUIPMENT WANTED!!! We are buying DEC systems, boards, terminals, drives and peripherals. Also Scientific Micro Systems (SMS), DSD, Datability, Dilog, other DEC compatibles, and Computer Output Microfilm (COM) units. Please call for a quote or fax us your equipment list. We buy, sell, and trade. **KEYWAYS, INC.,** 937-847-2300 OR fax 937-847-2350.

TEST EQUIPMENT for sale/wanted: RF, Microwave, video and fiber optic. Cable TV, Broadcast TV, satellite and related industries. Wavetek, Tektronix, Hewlett Packard and other manufacturers. Spectrum analyzers, signal level meters, sweep systems, TDRs, OTDRs, and much more. PTL Test Equipment, Inc. Phone 561-747-3647 FAX 561-575-4635.

FOR SALE: IFR 1200S Service Monitor with tracking generator (option 12). Excellent condition, **used in lab only** ($10k) **$8,500.** 410-381-7970. gor don@faders.com.

SOLDER EXTRACTORS: Pace MBT200 solder/desolder, $350; Pace SX25 with rotary vein pump bases rebuilt, $175; Weller DS100 mint, $250; Weller DS1000 digital readout, $350. Soldering stations: Weller EC2000 digital readout, $100, WTCP with Weller Ungar pencil new, $50. Ultrasonic cleaner, $75, Mesei **hot tweezers**, $50. 310-515-2058.

HP SPECTRUM analyzers: 8555A, 8558, 8559, others. Performance guaranteed. Metrowest Technologies PH 508-478-7613, FAX 508-634-3854. www.metrowesttech.com

POWER METERS, HP 432A, 8478A, $450; Wavetek 1034A, 1MHz-20GHz, -50/+10 dBm, AC or bat operation, $450; Boonton 42B, 10MHz-18GHz, $350; Boonton 42BD, digital 200KHz-12.4GHz, $450; Bird 43, $150. A-Comm Electronics 303-341-2283.

TEST EQUIPMENT for sale: http://www.A-COMM.COM

TEK 464 100MHz storage portable, $300; 454A 150MHz portable, $200; Racal 9000 500MHz counter, $95; 9913 200MHz counter, $55; HP 141T 110MHz spectrum analyzer, $700; 7015B plotter, $50; 1900A pulse generator, $75; 3403C RMS DVM, $90; 3581C 50KHz selective voltmeter, $125; 5257A transfer osc., $100; 5328A 500MHz counter, $125; 86250A 8-12.4 GHz plug-in, $150; ESI 291 RLC bridge, $95. 949-495-8649.

TEST EQUIPMENT for sale. Contact Ken for list. AFTC 248-666-4178, Fax 248-666-2669.

CUSHMAN SERVICE monitor CE5 with 301A-305B and manuals. Recent cal $500. CE5 with 302-305 repairable with manuals $200. Avionics set 307B-313 AM monitor $150. 315-839-5883.

BOONTON 82AD with manual $300. Wavetek Sam 1000 $250. Fluke 8060A $150. HP 8761A switch, new $40. 315-839-5883.

DATA RECORDS. Teac XR-5000 14 channel SVHS format $5,000. Sony PC-204 portable 4 channel DAT format $900. John 973-591-0523.

HP 3465A, HP 3465B digital multimeter, $100; HP 59306A relay actuator, $75; HP 428B, $50; GR 1311A, 1232A, 1142A, $50; HP 7475 plotter HP-IB interface, $200; HP 1744A oscilloscope, $200; HP 432A, $50; Tek 321 oscilloscope, $100; HP2225A printer HP-IB interface, $50; Tek TM506, $60; JDR 2000 oscilloscope, $150; Tek P6452, P6455 data acquisition, $25; Simpson multimeter 461, $40. Call 714-827-7345.

DECEMBER SALE! Austron 1200 quartz modules, four 5MHz outputs, <1x10-10/day, voltage control, vacuum bottle insulated, works with July QST GPS controller, $200. Many other frequency standards. Varion ion pump, ionization and capacitance gauges with readout. Corby Dawson 805-736-0288.

DATA-I/O 2900 programming system including LCC/PLCC and SOIC kits, lightly used, very clean, $2,500. Lorand Enterprises, LLC, 718-447-4747 or E-Mail: lorand@banet.net

TEK SCOPES: We have most 2200, 2400 series in stock. Competitive prices. Metrowest Technologies PH 508-478-7613, FAX 508-634-3854. www.metrowesttech.com

HP PLOTTERS, 7475A six pen HPIB, $250; 7470A, 2 pen HPIB, $200; 7475A, RS232, $150; 7550A, $400. A-COMM ELECTRONICS 303-341-2283.

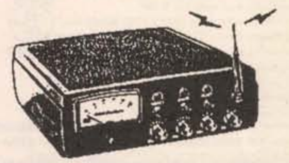
SPECTRUM ANALYZERS: Tek 7L5, 7L13 plugins and 490 series in stock. Metrowest Technologies PH 508-478-7613, FAX 508-634-3854. www.metrowesttech.com

TEK PLUG-INS: We have many on the shelf. Metrowest Technologies PH 508-478-7613, FAX 508-634-385. www.metrowesttech.com

SHOPPING FOR equipment: Metrowest Technologies, Bostons Equipment Supersource. Call for a quote on your next purchase. Metrowest Technologies PH 508-478-7613, FAX 508-634-3854. www.metrowesttech.com

SECURITY

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.



COUNTER-SURVEILLANCE=$250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **$250 HR** in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: **1-800-732-5000.**

FACTORY SALE! QVS 104: 4 BNC/RCA 12 pixels, 256 scale. 8.5" (W) x 2" (H) x 5.5" (L). $169 @ 5 pcs., $149 @10 pcs. Also available: 8-1 video auto-switcher, $65 @ 5 pcs., $58 @10 pcs. Distributors welcome. Matco, Inc., 1-800-440-0299 Fax: 630-350-9546. E-Mail: sales@mat-co.com Web site www.mat-co.com

---

SURVEILLANCE EQUIPMENT wanted. Audio, video, RF, telephonic, countersurveillance, communications, any other professional equipment. Fax 410-836-1190. E-Mail to Sales@swssec.com Voice 410-879-4035. www.swssec.com/used.html.

---

8 CAMERA DUO-QUAD DISPLAY BLOW-OUT. 8 camera B+W 2 page hi-res. real-time quad w/2 video outputs. Selectable display quad/sequencer or both. These units are brand new discontinued American Dynamics AD1475A. Similar units in this magazine are twice the price. Not a China imitation. Industrial unit. Our reg. price $350, **NOW $175 EA.** While they last! Pro-Vid Sys. 781-933-0827. E-Mail: RicksVideo@ MSN.COM

ALARM CATALOG of Ademco, Moose, Napco, CCTV, phones & more. 44 pages of equipment that only the professionals can buy. Send $2 to HES Electronics, POB 183, Brick, NJ 08723. Mention this ad and get a $10 off certificate! Visit www.heselectronics.com

---

Unlock a World of Performance!

STEP INTO THE FUTURE

ACE COMPUTERS

Delivering Power and Performance for Less Since 1983

1425 East Algonquin Road
Arlington Heights, IL 60005
(847) 952-6900
(847) 952-6901 FAX

intel. Authorized Solution Provider For 1996

Call Toll-Free 1-877-ACE-COMP

www.acecomputers.com

"The Ace GamePro 2000 is a great gaming system with a price you'll like as much as the games you'll play" - Computer Buyer's Guide and Handbook, October, 1998

"A Power User's Delight." - Computer Buyer's Guide, Summer 1998

"Ace loads its system with enough high end components to turn a power user's head." - Computer Shopper, August 1997

"Fast all around and affordable - an excellent value" - Computer Buyer's Guide and Handbook, July 1998

"Top 100 Direct Vendor" - PC Computing, February 1998

"BEST BUY - Ace has put together a system that's sure to please just about any consumer." - Computer Buyer's Guide & Handbook, May 1998

"High quality components, Fast speed and Reasonable price - A real business workhorse!" - PC Today,June 1998

"A fine system that would be valuable to any business - A great value" - PC Today,July 1998

"2 TIME BEST BUY - The right blend of nice touches - a computer worth seriously thinking about when it's time to buy." - Computer Buyer's Guide and Handbook, August, September 1998

CBG &H BEST BUY

Pro Series Notebooks

TRACER/TRAVELER

- Intel Pentium® 233MHz/Pentium®II Processor
- 12.1" or 14.1" Active Matrix Screens
- 20X or 24X CD-ROMs and 1.44M FDD
- 64 Megs SDRAM
- 3 or 4 GB Hard Drive
- 56KB Fax/Modem
- 3D Sound with speakers
- Touchpad Mouse
- Full Travel Keyboard
- Carrying Case Included!
- Windows 98 Included!
- 1 Year Warranty

TRACER WITH PENTIUM® 233 W/MMX® (12.1", 3GB, 20X CD-ROM) - $1499

TRAVELER WITH PENTIUM ® II - 266 14.1", 4GB, 24X CD-ROM - $2649

GamePro 2000

- Intel Pentium® II Processor w/512K Cache
- 64 Megs SDRAM/ 6.5GB Ultra DMA Drive
- Creative Labs DVD Drive Kit/1.44M Floppy
- US Robotics 56KB V.90 Fax/Modem
- Matrox G100 AGP with 8M SGRAM
- Diamond Monster II w/12M SGRAM
- Iomega 100 MB Zip Drive
- 20" (18.8" Viewable) SVGA Monitor
- Diamond Monster MX200® PCI Sound
- Pro SW-12 Subwoofer w/4 Satellite Speakers
- Microsoft Ergonomic Style Mouse/104 Kb
- Mini-Tower Case w/6 Bays
- Windows 98 Installed

PENTIUM ®II 300 - $2249
PENTIUM ®II 333 - $2279
PENTIUM ®II 350 - $2329
PENTIUM ®II 400 - $2479
PENTIUM ®II 450 - $2679

Discovery Station

- Intel Pentium® II Processor w/512K Cache
- 32 Megs SDRAM/4.3GB Ultra ATA Hard Drive
- 32X Speed CD-ROM Drive/1.44M Floppy Drive
- 56KB USR Fax/Modem w/Voice Mail
- AGP Video with 4M RAM
- 17" Monitor - 0.28 Dot Pitch
- Yamaha 3D Sound with Desktop Speakers
- Microsoft Intellimouse Mouse/104 Keyboard
- Mini-Tower or Desktop Case w/6 Bays
- Windows 98 or Windows NT 4.0(Add $99 for NT)
- 3 Year Complete Warranty Included

PENTIUM ®II 266 - $1279 • PENTIUM ®II 350 - $1379
PENTIUM ®II 300 - $1299 • PENTIUM ®II 400 - $1549
PENTIUM ®II 333 - $1329 • PENTIUM ®II 450 - $1749
Business/Personal lease as low as $47/Mo, 36 Months

Home/Office Pro +

- Intel Pentium® II Processor w/512K Cache
- 64 Megs SDRAM / 6.4GB Ultra ATA Hard Drive
- 32X Speed CD-ROM Drive/1.44M Floppy
- US Robotics 56KB Fax/Modem
- Matrox Productiva G100 AGP with 8M RAM
- Goldstar 17" Monitor - 0.26 Dot Pitch
- Sound Blaster 128 PCI with Subwoofer Speakers
- Microsoft Ergonomic Style Mouse/104 Keyboard
- Mini-Tower or Desktop Case w/6 Bays
- Windows 98 or Windows NT 4.0(Add $99 for NT)
- Office 97 Included!
- 3 Year Complete Warranty Included

PENTIUM ®II 266 - $1529 • PENTIUM ®II 350 - $1629
PENTIUM ®II 300 - $1549 • PENTIUM ®II 400 - $1799
PENTIUM ®II 333 - $1579 • PENTIUM ®II 450 - $1999
Business/Personal lease as low as $61/Mo, 36 Months

Dreamedia System

- Intel Pentium® II Processor w/512K Cache
- 64 Megs SDRAM/ 16.8GB Ultra ATA Hard Drive
- Creative Labs DVD-ROM Drive/1.44M Floppy
- US Robotics 56KB Fax/Modem
- Matrox G200 AGP with 8M RAM
- 20" SVGA Monitor with 1600 x 1280 Resolution
- Sound Blaster Live! PCI with Subwoofer Speakers
- Microsoft Ergonomic Style Mouse/104 Keyboard
- Mini-Tower Case w/6 Bays
- Windows 98 or Windows NT 4.0(Add $99 for NT)
- Office 97 Included!
- 3 Year Complete Warranty Included

PENTIUM ®II 300 - $2369 • PENTIUM ®II 400 - $2599
PENTIUM ®II 350- $2449 • PENTIUM ®II 450 - $2849
Business/Personal lease as low as $85/Mo, 36 Months

ACE PowerWorks ® Server 2400

- Single or Dual Intel Pentium® II or Xeon® Processors
- 128 or 256 Megs ECC SDRAM/Expandable to 2 Gig
- 3 - 4.5GB Ultra Wide SCSI2 RAID Hot Swappable Drives (3 - 9.1GB Ultra Wide SCSI2 RAID Hot Swappable Optional)
- 1.44M Floppy/32X SCSI2 CD-ROM Drive
- Integrated Intel PCI 10/100 Network Interface
- Microsoft Ergonomic Style Mouse/104 Keyboard
- Certified Server Chassis w/RAID Capability ("Cube Style for Xeon Processor")
- Remote Monitoring
- Windows NT Server 4.0 with 10 Client Licenses
- 4 Year National Onsite Parts and Labor Warranty Included!
- Professionally Tested with Novell, Windows NT & SCO Unix

1 CPU/128M/3-4.5GB Drives	2 CPUs/256M/3-9.1GB Drives
PENTIUM ®II 266 - $3679	PENTIUM ®II 266 - $4549
PENTIUM ®II 300 - $3729	PENTIUM ®II 300 - $4649
PENTIUM ®II 333 - $3779	PENTIUM ®II 333 - $4749
PENTIUM ®II 350 - $3899	PENTIUM ®II 350 - $4999
PENTIUM ®II 400 - $4049	PENTIUM ®II 400 - $5299
PENTIUM ®II 450 - $4249	PENTIUM ®II 450 - $5699
XEON ® 400 - $4799	XEON ® 400 - $6349
XEON ® 450 - $5149	XEON ® 450 - $6999

Business/Personal lease from $121/Mo, 36 Months

Custom Configurations Available!
*Optional on-site warranties available on all systems!

Intel® FINANCIAL SERVICES Leasing Available!

FCY2K VISA

*We accept all major credit cards. We accept Fortune 1000, Government, and Educational Institution Purchase Orders. We respond to invitations for governmental and educational open bids. Business leasing available to qualified applicants. Prices, appearance, and specifications subject to change without notice. 17" monitors are 15.9" VIS or better, 19" monitors are 18.0" VIS or better. Certain models may include upgraded components. All custom configurations are available. 15% restocking fee on returns of custom-built systems. 30 day return policy does not include shipping charges, incurred damages, or service charges. All returns must include original packaging, accessories, and documentation in as-new condition. Monitors may be manufacturerd by third parties. Viewable sizes of monitors vary. The Intel inside logo and Pentium are registered trademarks of Intel Corp.

Enhanced IDE & SCSI2 Hard Drives

Enhanced IDE and Ultra DMA Drives	
2.14 Gig Seagate/Western Digital,10 ms access	$119
2.55 Gig Seagate Medalist, 10 ms access	$125
3.2 Gig Seagate/Western Digital, 11 ms access	$135
4.3 Gig Seagate/Western Digital, 10 ms access	$145
5.1 Gig Quantum Ultra DMA, 9 ms	$159
6.4 Gig Seagate/Western Digital,Ultra DMA, 9 ms	$179
6.4 Gig Seagate Medalist Pro 7200 RPM,Ultra DMA	$219
8.4 Gig Quantum Fireball, Ultra DMA, 9 ms	$199
8.6 Gig Seagate Medalist, 9 ms	$199
9.1 Gig Seagate Medalist Pro 7200 RPM, Ultra DMA	$259
10.1GB Western Digital, 5400 RPM, Ultra DMA	$ 239
11.5GB Maxtor Diamondmax, 5400 RPM, Ultra DMA	$259
13.6GB Maxtor Diamondmax, 5400 RPM, Ultra DMA	$319
16.8GB IBM Deskstar, 5400 RPM, Ultra DMA	$439
SCSI2 Drives	
2.1 GB Quantum Atlas Ultra Wide, 8 ms, 7200 RPM	$ 189
3.2 GB Quantum Fireball Ultra SCSI, 9 ms	$ 229
4.5 GB Quantum Viking Ultra Wide SCSI2, 8 ms	$ 299
4.5 GB Seagate Barracuda Ultra/Ultra Wide, 7.9 ms	$ 449
8.7 GB Micropolis Tomahawk Ultra SCSI2, 8 ms	$ 399
9.1 GB Micropolis Tomahawk UW SCSI2 9 ms	$ 429
9.1GB Seagate Medalist Pro UW, 9 ms	$ 529
9.1 GB Quantum Viking UW SCSI2, 7.9 ms	$ 589
9.1 Gig Seagate Barracuda U2W 7.9 ms 1" High	$ 589
9.1 Gig Seagate Cheetah Ultra/Ultra Wide	$ 799
18.2 Gig Seagate 'Cuda/Cheetah Ultra Wide	$899/$1399

SVGA Cards and Accelerators

Diamond Stealth 3D, 2M PCI/4M AGP	$39 / $49
Diamond Speedstar AGP 8M	$69
Diamond Monster II 3D - 3DFX VooDoo2 8M/12M	$179/$249
Trident PCI 2M/AGP 4M	$29/$49
Matrox Mystique 220 PCI with 4M RAM	$89
Matrox Productiva G100 with 8M AGP	$79
Matrox Millenium II G200 AGP with 8M RAM	$129
Matrox Millenium II PCI 8M WRAM	$179
ATI All in Wonder Pro PCI/AGP with 4M/8M SGRAM	$189/$229
ATI Xpert @ Work/Xpert @ Play AGP 4M	$79/$99
Diamond Viper 550 Pro AGP/PCI with 16M RAM	$199
Diamond FireGL1000 with 8M SGRAM PCI/AGP	$169
Matrox Rainbow Runner for Millenium II -	$169
CAD ACCELERATOR CARDS - MANY IN STOCK PLEASE CALL!	

Memory - SIMMs/DIMMs

72 Pin SIMM Modules	
4M NonParity/EDO/Parity	$10/$10/$19
8M NonParity/EDO/Parity	$18/$18/$25
16M NonParity/EDO/Parity	$35/$34/$49
32M NonParity/EDO/Parity	$69/$65/$89
64M EDO/Parity	$109/$129
168 Pin DIMM Modules	
16M SDRAM 10 ns	$20
32M SDRAM 10 ns/PC100	$39/$45
64M SDRAM 10 ns/PC100	$85/$89
128M SDRAM 10 ns/PC100	$175/$185

Microprocessors

Pentium® II-XEON 450/400 w/512K	$1279/$934
Pentium® II- 450/400/350	$629/$449/$299
Pentium® II- 333/300/266	$249/$229/$199
Celeron® 333/300A/300/266MHz	$179/$148/$99/$85
Pentium® Pro 200 Mhz-512K/256K	$449/$249
Pentium® 233 MMX/200 MMX	$139/$109
Pentium® 200 Mhz/166 MMX	$149/$89
Pentium® 166 Mhz/133Mhz	$85/$79
AMD K6-300/266/233 MHz	$109/$89/$79
Cyrix 266/233/ 200	$89/$79/$69
Pentium®II/Pentium®Pro/Pentium®Fans	$12/$12/$8

ALL PROCESSORS COMPLETE WITH FULL WARRANTY!!!

SVGA Monitors

VISIONMASTER® iiyama AWARD WINNING!

Iiyama Visionmaster 350 - 15" 0.28 Dot Pitch	$229
Iiyama Visionmaster 400 - 0.26 Dot Pitch - 17"	$459
Iiyama Visionmaster Pro 400, 0.25 AG - Editor's Choice	$489
Iiyama Visionmaster 450, 19" 0.26 AG -Editor's Choice!	$629
Iiyama Visionmaster 500, 21" Monitor, 1800 x 1440	$999
Iiyama Visionmaster Pro 500, 21" ,1800 x 1440 Resolution	$1029
KDS VS-14" Non-Interlaced 0.28 Dot Pitch	$119
KDS VS-15" Non-Interlaced 0.28 Dot Pitch	$149
Sony Multiscan 15sf Trinitron, Digital	$289
KDS VS-7 - 17" SVGA, 0.28 Dot Pitch	$249
Megaplus 17" Non-Interlaced, 0.28 Dot Pitch	$299
Goldstar 78i Non-Interlaced 0.26 Dot Pitch	$329
KDS VS-9 - 17" SVGA, 0.26 Dot Pitch	$329
Panasonic S70, 0.27 Pitch, 3 Year/1Year onsite	$399
NEC Multisync XV17+ 0.25 Dot Pitch, CromaClear!	$499
KDS - 20" - 1600 x 1280, 0.28 Dot	$549
KDS V21 - 21" - 0.28 Dot Pitch, 1600 x 1280	$749
Viewsonic - Nokia - Hitachi - Mitsubishi - Others	CALL!

Don't See what you want listed? Just call us or see our Web site for a full catalog of fine quality products!

WWW.ACECOMPUTERS.COM

CD-ROM/Modems/More

CD ROM Drives	
Acer 32X EIDE, 83 ms	$49
Goldstar 32X EIDE, 79 ms	$49
Toshiba EIDE 32X, 85 ms	$59
Mitsumi EIDE 32X, 90 ms	$55
Toshiba SCSI2 32X, 85 ms	$99
Plextor Ultra SCSI2 32X, 75 ms	$169
Mitsumi 2X/8X EIDE CDR Kit	$229
HP CD-ReWriter EIDE 4X/2X/24X	$399
HP CD-Writer Parallel 4X/2X/24X	$499
Teac 4X/12X SCSI CD-Writer	$399
Plextor Plexwriter 4X/12X SCSI2	$399
Yamaha 4X/6X SCSI2 CD-RW	$429
Ricoh CDR-74 Media, 25 Pack	$ 40
Creative Labs DVD2 Kit ($30 Rebate)	$199
Modems	
Generic V.90 Internal with Voice	$59
Diamond Supra 56K Internal	$99
USR Sportster 33.6 Int/Ext	$79/$89
USR Sportster 56K Int/Ext	$99/$129
USR PCMCIA 33.6 w/XJack	$199
USR PCMCIA 56K w/Ethernet	$329
3COM PCMCIA 33.6/Ethernet	$199
Networking	
3Com 3C905TX - 10/100 Card	$69
Intel Etherexpress Pro 10/100	$69
5/8/16 Port 10 BT Hub	$49/$79/$99
Hubs/Switches/More	CALL

Motherboards for Pentium® Processors

bcm

BCM 575- AT-430TX,P75-233PCI w/512K,DIMM,MMX	$89
Tyan Tomcat 4, Dual CPU, w/8 SIMMs,512K	$159
Tyan Turbo-2 AT/ATX, Intel 430TX w/6 SIMM/2 DIMM 512K	$ 89
SuperMicro P55MMS98-Intel 430TX, 512K	$89
Quicktek, P75-200 w/Adaptec 2940UW SCSI2,512K Pipe.	$159
ASUS TX97/TX97E, AT-430TX, P75-233 PCI w/512K	$89
Motherboards for the Pentium® Pro Processor	
BCM 600 - 150-200 MHz, Intel 440FX Chipset, PCI/ISA	$179
Supermicro,AT or ATX 150-200, Intel 440FX, PCI/ISA	$129
Tyan Titan Pro - Single/Dual processor PCI/ISA, AT or ATX	$149/$249
Intel PR440FX - Dual Pro, UW SCSI,10/100 LAN, Audio, ATX	$429
Motherboards for the Pentium® II Processor	
BCM 632 - Intel 440LX Chipset, PCI/ISA/AGP/AMI BIOS	$ 109
BCM 0S440BX - Intel 440BX Chipset, 100 Mhz Bus	$ 139
Intel AL440LX - Intel 440LX, PCI/ISA/AGP/DIMMs,Audio,ATX	$ 139
Intel SE440BX - Intel 440BX, 100 Mhz Bus, Audio	$ 169
Intel DK440LX/R440LX-Adaptec , LAN, Audio, 2 CPU	$ 449
Intel N440BX/T440BX - Adaptec, LAN, Dual/Single	$579/$379
Asus P2B - Intel 440BX, PCI/ISA/AGP, ATX	$ 149
ABIT LX-6 - Intel 440LX, PCI/ISA/AGP, ATX	$ 119
ABIT BH-6 - Intel 440BX, PCI/ISA/AGP, ATX	$ 129
Soltek SL61B - Intel 440LX, PCI/ISA/AGP/ AT, SIMM/DIMM	$ 129
Soltek - Intel 440BX, 100 Mhz Bus, AGP/PCI/With SCSI2	$ 119/ $229
Supermicro P6DLE-440LX,Dual P2,PCI/AGP/DIMM	$ 229
Super P6SLS/DLS-440LX,One/Dual P2,PCI/AGP/UW SCSI	$219/$299
Supermicro P6DBU-440BX,Dual P2,PCI/AGP/DIMM/Dual SCSI	$ 399
Supermicro P6SBU-440BX,Single P2,PCI/AGP/DIMM/Dual SCSI	$ 299
Supermicro P6SBA - 440BX/PCI/ISA/AGP/ATX, 100 Mhz	$ 149
Tyan Tsunami - 440BX/PCI/ISA/AGP/ AT Form Factor	$ 159
Tyan Tiger II - 440LX- Dual Processor, ATX	$199

Boards for the Pentium® II XEON Processor IN STOCK!

Closeout boards for the Pentium® Processor	
QDI - P75-200, 256K Cache, 430FX	$ 49
BCM 591/593 - P75-200, 256K Cache, 430VX	$ 49
BCM 594 - P75-200, MMX, 256K Cache, 430VX	$ 49
BCM 594 - P75-200, MMX, 512K Cache, 430 VX	$ 69
Supermicro P5CMS- Intel 430FX, 256K Cache	$ 59
Tyan Tomcat II - Intel 430HX, Dual Processor	$ 89
Tyan Titan III - Intel 430FX, 5 ISA/4 PCI/6 SIMM, 256K Cache	$ 59

AMATEUR SCIENTISTS: Surplus magnetic sensor board with Honeywell Micro SS94A1 Hall-Effect transducer (alone worth $15) and other goodies. Output varies with magnetic field, two for $10 postpaid. Check/MO to John Hill, 5734 Vickie Dr., Winston-Salem, NC 27106.

FACTORY SALE! CNL100, CNP101: 1/3" CCD, 430 line horiz., 12V/100mA, lens and pin hole types, lens 3.6mm/F2.0, 1.27" (W) x 1.27" (L) x 1" (H). $43 @ 5 pcs., $38 @ 10 pcs. Distributors welcome. Matco, Inc., 1-800-440-0299 Fax: 630-350-9546. E-Mail: sales@mat-co.com Web site www.mat-co.com

---

FACTORY SALE! IC 113: PIR motion detector w/ NO/NC alarm output. CCD camera with audio can be turned on by detector. 5-1/4" (L) x 2-3/4" (W) x 2" (D). $89 @ 5 pcs., $82 @ 10 pcs. Matco, Inc. 1-800-440-0299 Fax: 630-350-9546. E-Mail: sales@mat-co.com Web site www.mat-co.com

---

FACTORY SALE! AS 1000, 2.4GHz transmitter & receiver. Capable handling total of 4 wireless cameras, range: >300'. Built-in camera, 380 TV line. $189 @ 5 pcs., $179 @ 10 pcs. Additional camera $99 @ 10 pcs. Matco, Inc. 1-800-440-0299 Fax: 630-350-9546. E-Mail: sales@mat-co.com Web site www.mat-co.com

---

FACTORY SALE! PS 102: Built-in pin hole CCD, lens size: 1.2mm. 5-1/2" (D) x 1.7" (H). $69 @ 5 pcs., $65 @ 10 pcs. Distributors welcome. Matco, Inc., 1-800-440-0299 Fax: 630-350-9546. E-Mail: sales@mat-co.com Web site www.mat-co.com

SATELLITE EQUIPMENT

USED SATELLITE EQUIPMENT. You name it, we have it. LNAs, downconverters, drives, receivers. Working condition guaranteed. Call 765-385-2305.

FREE SATELLITE TV CATALOG. Tech books, installation videos, analysis software. Call **1-800-843-2425** or **www.baylin.com**

SATELLITE EQUIPMENT available: Receivers $25 and up; 20-25 LNB $30; C-KU feed horns $65. Call 757-599-4408.

FREE BIG dish catalog. Low prices! Systems, upgrades, parts, and "4DTV." Skyvision, 1010 Frontier Dr., Fergus Falls, MN 56537. www.skyvision.com **Call 1-800-543-3025.**

L BAND quadrifilar T/R antenna, 55 dB LNA, 20 watt HPA, works great for remote GPS. Info at afstar.com

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

BEST PRICING on 18" satellite TV systems for home and RV. DSS, DISH Network programming, multi-room viewing options, accessories. www.skyvision.com **Call 1-800-543-3025.**

KU UPLINK. 5.6 meter antenna, modulators, upconverters, TWT HPAs, exciter, test equipment, 26KVA generator. Closing company. Must sell lots of equipment. Call 1-800-869-7827 or visit www.starcom.com for list.

DSS TEST CARD information. Call toll free, 1-888-416-7296.

FREE SATELLITE TV INSTALLATION TOOLS AND EQUIPMENT CATALOGUE: for complete installation. Consumers, dealers, distributors and technicians welcome. **1-800-646-8665 or www.natropolis.com or fax 651-641-1898. Natropolis, Int'l, PO Box 14115, St. Paul, MN 55114.**

1998 DSS SOFTWARE COOKBOOK 700+ CD-ROM COLLECTION CLONING REVERSE-ENGINEERING, PPV, ADULT, EMULATORS, DIAGRAMS, SCHEMATICS, PATCHES, PLANS, MUCH MORE. (SPECIAL: 1ST 500 ORDERS GET 500+ ADDITIONAL PROGRAMS!) WHOLESALE ONLY $22 (BUY 2, GET 1 FREE!!!). DSS TEST-CARD INFO SOURCE MANUAL $10. VISA/MC/AMEX/COD/CHECKS/MO. BRINKER ENGINEERING LABS, USA. CALL NOW 352-429-5496.

WHAT! YOU don't have **TELECODE's NEW 1998 "HACKER CATALOG,"** yet! 125+ items. Call 520-726-2833. Surf online at http://www.hackerscatalog.com

MILITARY SURPLUS ELECTRONICS

MILLIONS $$$ in "scrap gold" from old computers and electronics junk. Message: 603-645-4776 or www.tiac.net /users/quiksand/goldtek.htm

AUDIO – VIDEO – LASERS

8x8 PORT video/stereo audio switch. Electronic wideband patch panel eliminates complex wiring of your video and audio components. Easy signal routing via front panel controls using the MMCS-10. Call Communications Systems Labs at 1-800-529-9483 or check our web site at **www.commsyslabs.com** for this and more.

ANTIQUE VIDEO TRANSFER SERVICE: transfer of any 2" quadruplex video tapes. Quad TV spots, features, medical, corporate, military, government, and university tape libraries TRANSFERRED TO VHS. Affordable. Phone/fax 415-821-7500. If no answer call 415-821-3359 or pager 415-245-8700.

MOD CHIPS for Sony PlayStation. Now your backups will work. Only $9.95 ea. + $3 shipping. Call 1-888-467-6150, all major credit cards accepted. Computers & components at wholesale prices. www.cconusa.com

BROADCAST VIDEO equipment wanted: all types, new or old. Please call, Jon with info. 1-800-539-2859.

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

FREE LASER CATALOG. Helium-Neon, Argon, ruby, visible laser diode modules, lightshows, holography, laser pointers. Lowest prices. Midwest Laser Products, PO Box 262, Frankfort, IL 60423. 815-464-0085 **www.midwest-laser.com**

SYNC-A-LINK UNIVERSAL VIDEO SYNC GENERATOR restores all horizontal & vertical sync lines, DC level, compensates for inverted video, color phase, from standard or distorted analogue video-type formats. Comes complete with operations manual & 90-day warranty. $160. 918-479-6451 or write to Sync-A-link Communications, PO Box 4, Locust Grove, OK 74352.

WANTED: PRO video equipment, VCRs, switchers, cameras, etc. Advanced Media 702-874-1911.

LASER POINTERS hottest novelty craze! Bullet style, metel cased, keychain pointers (not the cheap plastic styles). Highest quality, brightest laser for legal US use. Each packed in brilliant display case with batteries. All factory new and sealed with full one year warranty. We wholesale with the lowest prices on any quantity. Gentry Communications 507-332-2788.

SONY PLAYSTATION MODCHIPS. Allow you to play CDR backups & imports. $10 ea. + $3 shipping. Quanity discounts. 619-590-9320.

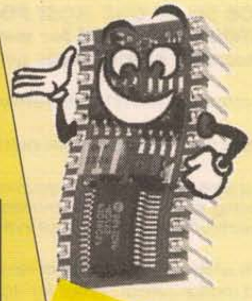
You Win with Nuts & Volts

Subscribe today and be automatically entered in our *new* MONTHLY PRIZE DRAWING!!!

OCTOBER PRIZE

BASIC Stamp II Professional Package

A custom-built package consisting of the following parts:



JOHN DOGGETT from Rovisdale, AL IS OUR LUCKY WINNER OF THE OCTOBER PRIZE!! CONGRATULATIONS, JOHN!

• (1) Standard Servo

Provided compliments of **PARALLAX, Inc.**

A $350 Value

NOVEMBER PRIZE

HARD DRIVE DUPE-IT! PRO from CORPORATE SYSTEMS CENTER

Pro model loaded with IDE interfaces, and drive

A $995 Value

THE WINNER OF THE NOVEMBER DRAWING WILL BE ANNOUNCED IN THE JANUARY 1999 ISSUE!

To Subscribe –
Just fill in and mail the enclosed subscription card or call our toll free orderline at (800) 783-4624 with a Visa or MasterCard.

ATTENTION CURRENT NUTS & VOLTS SUBSCRIBERS:

If you have a current, paid subscription to Nuts & Volts, you are automatically entered each month in our drawing!!

We now offer a three-year subscription for only $51.00!! *(USA delivery only)*

If you do not wish to order a subscription, but would like to be entered in our drawing, simply ***send or E-Mail*** your name, address, and telephone number, to NUTS & VOLTS, 430 Princeland Court, Corona, CA 91719, drawing@nutsvolts.com. *No phone entries accepted.* All orders/entries must be *received* by October 31st to be included in the October drawing. November entries must be *received* by November 30th.

Check us out on the web!
http://www.nutsvolts.com

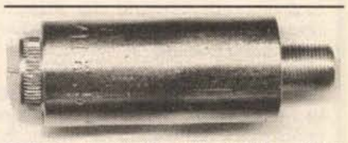
CREATE 3-D video images with the Visual Eyes Video system. Phone or fax 918-479-6451 or write to Sync-A-Link, PO Box 4, Locust Grove, OK 74352.

CABLE TV

DEALERS: NEW VM8000 cable converter. Sharp tuner, 800MHz. 125 channels. Call for lot pricing. NTS 1-888-355-6687.

TOCOM UNMOD. 5503 cable converters $6 each. Call **706-398-2100.** 10 lot min.

UNMODIFIED JERROLD 212 converter $50. 97.5, 106.5, 108.5, AB filters $12 ea. DIGITAL 125ch PRO converter $150 ea. 10 lot. The best converters you can buy! Please call 1-888-561-4796. http://members.aol.com/Metro32168/index.html



NOTCH FILTERS 110, 108.5, 106.5, 97.5 75dB deep notch. $19.95 ea., 1-5 qty. $15.95 ea., 6-10 qty. $11.95 ea., 11-20 qty. $9.95 ea., 21 or more qty. Call 24 hr. order and information hot line 516-389-3536.

PANASONIC CATV converter, unmodified (Plain Jane) model TZ-PC 1203N, TZ-PC 1103N and others **priced very low. 407-676-2530.**

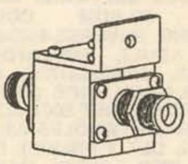
NEW! CABLE converter electronic service equipment and supplies for most cable converter boxes. Highest service, lowest prices. Call Ken Erny Electronics. 24 hr. order and information hot line 516-389-3536.

ADEAL4U WHOLESALES BIG SAVINGS $$$ BEST QUALITY - NO CHEAP CLONES 888-387-1248 www.adeal4u.com

JERROLD UNMODIFIED CONVERTERS FOR SALE. CALL FOR BEST PRICES. **NO DESCRAMBLER SALES.** CALL BRLD ELECTRONICS 1-800-322-6316.

PIONEER 6110, 6310s, READY TO GO, SATISFACTION GUARANTEED, SORRY NO NEVADA SALES, LESS BUSTERS ELECTRONICS, 702-642-0325, WEB: WWW.lessbuster.com

PICS, GALS READ if you've lost your masters. Programming service available. Call for info. Network Sales, 616-683-0500.



EXPLOSIVE CABLE TV GRAB! BRINKER ZAPPER/SNOOPER STOPPER combo module all in one! Buy wholesale factory-direct, no middleman. Let others get fined + zapped instead. 100% COMPATIBLE. Your order shipped NATIONWIDE immediately! LIFETIME GUARANTEE! VISA/MC/AMEX/COD/MO/CHECKS. ONLY $10 (SPECIAL: 3/$20 plus FREE DESCRAMBLER PLANS!). SUPER ZAPPER MODULES ONLY $16! (3/$33)! Use SUPER ZAPPERS if you have COX, TCI, WARNER in: CA, TX, FL, NY, PA, MI. DESCRAMBLER PLANS (4=$5, 20=$15) 130+ DESCRAMBLER SOURCES ($5). FREE SHIPPING. OPEN 24 HOURS! 352-429-5496. BRINKER ENGINEERING LABS, USA.

125 CHANNEL Digital Pro converter with audio & video $82 each. Panasonic TZ-PC175DG2-7 converter with volume control $135 each. The best converters you can buy! Please call 1-888-561-4796.

UNMODIFIED CABLE CONVERTERS. Zenith ST1600, ST1086, ST300, Panasonic 175, 145 vol. & non-vol. Regal RR-92 & RC 83, DP5, DP7, DRZ, 5503 VIP, SA 8580. Guaranteed low prices. Please call for more converters 405-631-1856.

WANTED PIONEER 6110, 6310 CONVERTERS, RAW, TOP CASH, LOTS 5 OR MORE. 702-64S2-0325.

PLANS: DESCRAMBLE CABLE FOR UNDER $12. PLUS TWO FREE BONUSES. TOLL FREE 1-888-588-3715.

FREE CABLE DESCRAMBLER PLANS! For details write: Sierra Publishing, 909 E. Yorba Linda Blvd., Suite H-181, Dept. NVJ, Placentia, CA 92870.

PANASONIC CATV converter, unmodified (Plain Jane) model TZ-PC 1203N, TZ-PC 1103N and others **priced very low. 407-676-2530.**

UNMODIFIED ST 1000 and ST 4000, $20 ea. Bill 419-385-3100.

AS-IS converters Oak Sigma, $20; Zenith, $7; genuine unmodified DPV5, $10. Call John 419-243-7856.

CABLE CONVERTERS, remotes, etc., free flyer. Jake 1-800-879-9657.

CABLE PARTS! Computer parts. Call for great prices or visit us on the Web: HTTP://WWW.CB-Electronics.com or call 1-800-436-8630.

SA UNMODIFIED all makes and models. Call for **best prices 706-398-2100.**

TOCOM UNMOD. 5503 cable converters $6 each. Call **706-398-2100.** 10 lot min.

CBTV REPAIR. We specialize in all converters, including Zenith. Give us a call: 405-634-1535.

ONE STOP shop. We carry a full line of CBTV equipment for all your cable needs. Also a wide variety of converter parts and accessories. Call for free catalog: 405-631-5153, FAX: 405-631-4788.

CABLE CONVERTER repair and upgrades most models, warranty. Call 972-304-5874.

ATTENTION: YOU'VE tried the rest, now go with the best. **UNICORN ELECTRONICS** where our valued customers **ALWAYS** come first. **CABLE CONVERTERS AND ACCESSORIES.** We will beat all competitors prices **GUARANTEED. All UNITS** in **STOCK FOR IMMEDIATE SHIPMENT. FREE** batteries and coax cable. **FREE** bullet protection with every unit purchased. **FREE** shipping with a $500 purchase or more. **NO** COD charges. **ALL** products come with a 1 year warranty and a 30 day money back guarantee. Please give us a call TOLL FREE 1-888-738-8181 9am to 6:30pm EST. **VISA, M/CARD, DISCOVER, COD. UNICORN** Electronics does not advocate unauthorized use or theft of cable services.

MOD CHIPS for Sony PlayStation. Now your backups will work. Only $9.95 ea. + $3 shipping. Call 1-888-467-6150, all major credit cards accepted. Computers & components at wholesale prices. www.cconusa.com

WANTED: TEKNIKA 6510 cable converter boxes/parts. 415-221-5940.

UNMODIFIED, POWER-UP, Pioneer BA: 6110, $75; 5135 $45; 5125 $25; Jerrold DP5, channel 2: $19, DPBB 7312, $95; S/A 8590-7S7 (11 button) $95. Minimum 10-lot. 405-631-5153.

LOW COST plain converters: Pioneer BC 4135, Hamlin CR-6000, DRZ-3, they're all 450MHz, 70 channel comes with new remote, 1 year warranty for only $15 each. Panasonic: TZPC-170, 450MHz with volume, $25 each; TV-86, $25. Minimum 10-lot. Call 405-634-1535.

GENUINE UNMODIFIED JERROLD DPBB 7312. 1-800-804-8655. E-MAIL: CLEWIS7298@AOL.COM

CABLE PARTS & EVERYTHING. Parts & accessories. Best prices & quantity discount. WE DON'T SELL BOXES. 1-800-MODULE-0.

SONY PLAYSTATION MODCHIPS. Allow you to play CDR backups & imports. $10 ea. + $3 shipping. Quanity discounts. 619-590-9320.

TOCOM UNMOD. 5503 cable converters $6 each. Call **706-398-2100.** 10 lot min.

CONVERTERS WHOLESALE Regal CR83 $35 each/10 lot. Panasonic 145-3 $45 each/10 lot. Panasonic 175-3 $50 each/10 lot. We also stock TV86, Timeless, RA550E, and Trivisions. Large selection of replacement remotes and batteries. Lowest prices on any quantity. Wholesale/distributors welcome. Gentry Communications. 507-332-27

PANASONIC TZPC175-3DG2: the original 175 with volume, parental control, and channel 3 output. Ideal for all your projects. $50 each/10 lot. With remote! All units fully guaranteed, RAN, and repacked. We are the lowest priced wholesaler of Panasonic equipment. Gentry Communications. 507-332-2788.

ZENITH ST1000 unmodified $16 each. Call **706-398-2100.** 10 lot min.

ZENITH ST1600 unmodified $60 each. Call **706-657-4445.** 10 lot min.

JERROLD FACTORY genuine unmodified DP7112. Like new DPV5 $28. Tocom VIP parts units $5 each. Call 1-800-500-9825.

SA UNMODIFIED all makes and models. Call for **best prices 706-398-2100.**

PANASONIC TZPC145-3: the original 145 with parental control and channel 3 output. $45 each/10 lot. With remote! All units fully guaranteed, RAN, and repacked. We are the lowest wholesaler of Panasonic equipment. Gentry Communications. 507-332-2788.

BATTERIES WHOLESALE. Heavy duty AA and AAA batteries. These are ideal for remotes, toys, and small electronics. 24 batteries per box. Cells start at 12¢ each! Fully guaranteed in factory packed boxes. Wholesalers and distributors call for case quantities. Gentry Communications. 507-332-2788.

GENUINE UNMODIFIED TOCOMS VIP. CALL 717-401-3438.

PIONEER DAYS. Factory original unmodified 10 lot. Pioneer 6110 $65; 5130 $50; factory genuine unmodified 99 channel Zenith $38; factory genuine unmodified True 99 channel 550MHz; Tocoms 5503 VIP $50 replaces 5507s. 1-800-500-9825.

TOCOM UNMOD. 5503 cable converters $6 each. Call **706-398-2100.** 10 lot min.

FILTERS IN STOCK, limited supply. 110, 108.5, 106.5, 97.5 MHz notch. Round and square types. $14 to $20 each. Highest quality. **407-676-2530.** Mention ad number F100.

Write in 69 on Reader Service Card.

RAW UNMODIFIED addressable converters. Major makes and models, new and refurbished. Wholesale pricing. Dealers only. Call now for best selection 702-338-3900.

CABLE CONVERTERS. Buy, sell, repair. All major makes and models. Blank PICs. 1-888-836-6060.

BOARD R US, for all your cable needs or computer software, programming service available. 4 MHz resonators 3 pins as low as $.34. For info call 909-948-3736 or visit us at our web site http://members.aol.com/BoardRUs

SA UNMODIFIED all makes and models. Call for **best prices 706-398-2100.**

GENUINE UNMODIFIED JERROLD DPBB7312 FOR SALE 10 LOT MIN. CALL 708-715-6118.

WANTED: GENUINE RAW UNMODIFIED CABLE TV CONVERTERS. TOP CASH PAID. CALL 708-715-6118.

UNMODIFIED CABLE CONVERTERS: JERROLD, SCIENTIFIC ATLANTA, PIONEER, ZENITH, TOCOM. MIN 10 LOT. CALL 708-715-6118

ZENITH ST1000 unmodified $16 each. Call **706-398-2100.** 10 lot min.

Closing Date For Next Issue – December 5th!

TELEPHONE/FAX

BEEPER, TWO-WAY radio repairs, modifications, duplications, all models, test equipment. Call TJ 718-341-1849, Fax 718-978-4616.

TELEPHONE CATALOG of Panasonic, SWBell, VTEC and more, including alarm systems, parts, and all phone accessories. Send $2 to HES Electronics, POB 183, Brick, NJ 08723. Mention this ad and get a $10 certificate! Visit www.heselectronics.com

BLUE BOOK PHONE REPAIR. 1000 models answering machines, cordless, $25. KEN's, 2825 Lake, Kalamazoo, MI 49001 616-345-4609. www.kenselectronics.com

NEW: MEMORECS system, private outgoing messages, DTMF logging, I/O control, interfaces answering machine. Oricom Technologies, 303-449-6428. www.sni.net/~oricom

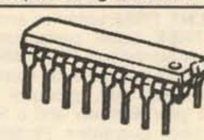
PHONE SYSTEMS WANTED!!! We buy AT&T MERLIN, SYSTEM 25/75/85 and other AT&T phone systems. Please call for a quote or fax us your equipment list. **KEYWAYS, INC.,** 937-847-2300 or FAX 937-847-2350.

WHAT! YOU don't have **TELECODE's NEW 1998 "HACKER CATALOG,"** yet! 125+ items. Call 520-726-2833. Surf online at http://www.hackerscatalog.com

COMPONENTS

DON LANCASTER'S ACTIVE FILTER COOKBOOK is back in print. Autographed copies of the seventeenth(!) classic printing $28.50. **SYNERGETICS PRESS,** Box 809-N, Thatcher, AZ 85552. 520-428-4073. Visa/MC.

MILLIONS $$$ in "scrap gold" from old computers and electronics junk. Message: 603-645-4776 or www.tiac.net/users/quiksand/goldtek.htm



WANTED: EXCESS ELECTRONIC INVENTORIES, ICs, MEMORY, EPROMs, PALs, LEDs, CIRCUIT BOARDS, DIODES, AND TRANSISTORS. CALL ACTIVE MICRO, 435-867-8660 OR FAX 435-867-8663.

PHOTOMULTIPLIER TUBES, radiosondes, electro-luminescent panels, electronic parts, test equipment. **www.lonemtn.com**

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

SMT COMPONENTS and complete SMT manufacturing system. Closing R&D/manufacturing company. Must sell lots of equipment. Call 1-800-869-7827 or visit www.starcom.com for list.

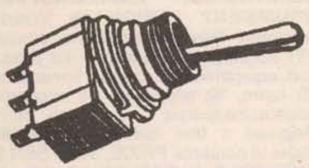
FACTORY SALE! CNL100, CNP101: 1/3" CCD, 430 line horiz., 12V/100mA, lens and pin hole types, lens 3.6mm/F2.0, 1.27" (W) x 1.27" (L) x 1" (H). $43 @ 5 pcs., $38 @ 10 pcs. Distributors welcome. Matco, Inc., 1-800-440-0299 Fax: 630-350-9546. E-Mail: sales@mat-co.com Web site www.mat-co.com

IC PULLOUTS, other components, sold cheap. Buying unused connectors, especially coaxial and "round plugs." www.ncci.net/millermetal

COMPONENTS: 74LS00B1 5¢, 74LS164P 5¢, 74LS165AN 5¢. BOURNES 500 OHM 20T pot 10¢, All parts are unused in tubes, quantity orders welcome send check or money order to Lloyd's, 27315 Jefferson Ave. Ste. J-17, Temecula, CA 92590. $3 for postage and handling.

Write in 70 on Reader Service Card.

OLD ICs & TRANSISTORS WANTED: HIGHEST PRICES PAID please FAX your list with part number, quantity & condition of **any semiconductors** to Rick @ ESI, 5363 Broadway Ave., Cleveland, OH 44127. 216-441-8500 FAX 216-441-8503. Since 1946! www.electronicsurplus.com

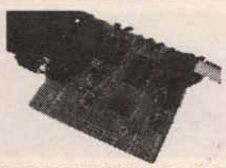


AMAZING! 35¢ ALL TOGGLE SWITCHES. Brand new. Rated 6A/125V. Hardware included. 1/4" panel hole. SPDT or DPDT on-on, or on-off-on. Minimum 100pcs./package. Add $6 freight. Gateway Products Corporation, PO Box 936397, Margate, FL 33093, 954-974-6864, Fax: 954-974-6818, VISA/MC, no COD.

WANT TO Buy: ICs, military & aircraft relays, diodes, transistors, Cannon, TRW, Amp, Burndy, Deutsch, Bendix connectors, electronic test equipment & most components. Hoffy Electronic Ent., 818-718-1165, FAX 818-341-5506.

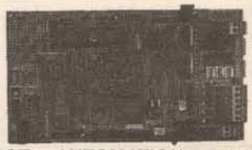
FOR SALE: Tubes galore! Send SASE for latest list "X." TYPETRONICS, PO Box 8873, Ft. Lauderdale, FL 33310-8873. 954-583-1340, Fax 954-583-0777. Fred Schmidt N4TT. WANTED: MS (military green) connectors, and door knob capacitors.

MICROCONTROLLERS



PIC MICROCONTROLLER PROGRAMMER KIT. Super value at $14.95 + $4.95 shipping. See our web site for the complete range of PICs that can be programmed. Includes PCB, parts and instructions. P16PRO shareware must be downloaded from the web. Amazon Electronics, tel 1-888-549-3749. Lots of other products. http://www.electronics123.com

DATA ANALYZER, logger, reader for PIC 16cxx, Atmel-89cxxx type micros. DB9 Com2 serial port hookup. Compact unit with software $800. E-Mail: picrat@themetronet.com Bluejay Electronics, Box 9, Grand Rapids, OH 43522.



PICBOT AUTOMATION controller. Single PCB with extensive I/O and sensory for home & office automation, robotics, and light industrial applications. Includes **20MHz 8-bit RISC MCU**, up to **512K SRAM & FLASH, dual H-bridge motor drivers, dual serial COM ports, stereo digital audio, 14 Darlington drivers, 6 high-current drivers, 8 LED drivers, IR remote sensor, and user prototype area with 10 PIC I/O (A/D) lines and SMT pads.** Includes an object-oriented stack-based interpreter that runs applications from any text file on a PC. Runs off any DC power source from +6V to +24V, and connects directly to PC COM port for easy programming and configuration. **Single PCB solution for mobile robot projects**. Prices from $199 quantity 1. Webo Technology, 408-690-9660. Fax 408-279-3211 www.webo.com

8051 DEVELOPMENT System. $149. **DPR Microtech 1-888-495-7655.** http://home1.gte.net/dpryan0/index.htm

P-BRAIN microcontroller. A very compact 68HC11 module that is ready to go with EEPROM and RAM, about 1 inch square and 1oz. in weight. http://members.aol.com/fuboco E-Mail: fuboco@juno.com Tel: 561-575-1487. Future-Bot Components.

ATMEL 90S1200/89C2051 PROTOTYPE BOARD. High quality 2x3 bare board with 1x2 prototype area. Supports RS-232 interface, regulated power supply, connectors. Includes schematics for board and interactive programmer. Send check or money order for $15.50 to: 2051BC, 1826 Lambeth Way, Carmichael, CA 95608. 916-487-2513. **WWW.2051BC.COM**

ANTIQUE ELECTRONICS

RADIO TUBES and phono. needles. 870-347-2281.

WESTERN ELECTRIC WANTED: 1920's-1960's. Amplifiers, mixers, preamps, speakers, tubes, etc. FREE OFFER 1-800-251-5454.

CRYSTAL SETS. Parts, plans, books, kits. Largest source in the world. Catalog $2. MIDCO, PO Box 222288, Hollywood, FL 33022.

WANTED: FOR historical museum, pre-1980 microcomputers, magazines, and sales literature. Floyd, VA 24091-0341 (540-763-3311/540-382-2935).

WESTERN ELECTRIC WANTED: 1927-1960S. Amplifiers, speakers, tubes, etc. Free offer. 1-800-251-5454.

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

TELEGRAPHY INSTRUMENTS, KEYS SOUNDERS, RELAYS, METERS, VIBROPLEX'S, PRACTICE SETS, INSTRUCTOGRAPHS, CALL BOXES, ETC. GOODMAN 217-345-6771.

WHOLESALE CABLE BOXES

CONVERTERS · FILTERS

Call Us To Satisfy All Of Your Cable Equipment Needs!

WE CARRY ALL THE MAJOR BRAND NAMES!

THE BEST DEALER PRICING!

30 DAY MONEY BACK GUARANTEE!
1 YEAR WARRANTY

Call Now and Take Advantage!!!

MODERN ELECTRONICS
1-800-906-6664
2609 S. 156TH CIRCLE • OMAHA, NE 68130
VISIT OUR WEB SITE: http://www.modernelectronics.com
E-MAIL: modern@modernelectronics.com

Write in 73 on Reader Service Card.

ATTENTION DEALERS/DISTRIBUTORS

BUY DIRECT FROM THE MANUFACTURER

THESE AND OTHER VIDEO SECURITY PRODUCTS NOW AVAILABLE!!! (DEALERS/DIST. ONLY) Minimum Order.

CCD Cameras	Qty 5	Qty 10	Qty 20	Qty 50+
B&W Board	$57	$52	$47	Call!
B&W Board/sound	$62	$57	$52	Call!
B&W Mini	$65	$60	$55	Call!
Color – Mini	$150	$142	$135	Call!

*B&W CCDs use Sansome Chips. Color CCDs use Sony.

CCD Camera Hidden Inside a "Magnavox" Clock

CCD Clock	Qty 5	Qty 10	Qty 20	Qty 50+
B&W Wired	$144	$129	$114	Call!
B&W Wireless	$289	$264	$248	Call!
Color Wired	$234	$218	$199	Call!
Color Wireless	$387	$362	$345	Call!

Wireless use 2.4Ghz standard transmitters and receivers.

Call ATN Today for the Best Prices and Quality Security Products.

American Technologies Network Corp. 1(800)910-2862
20 S. Linden Ave. #1B 1(650)875-0130
S. San Francisco, CA 94080 fax:1(650)875-0129
www.atncorp.com sales@atncorp.com

Write in 74 on Reader Service Card.

THE CASE AGAINST PATENTS. Don Lancaster's tested and proven alternatives that work in the real world. $28.50, Synergetics Press, 3860 West First Street, Box 809, Thatcher, AZ 85552. 520-428-4073. synergetics@tinaja.com VISA/MC.

ELECTRONIC EAVESDROPPING EQUIPMENT DESIGN by Winston Arrington. This revised edition contains 117 schematics and text of our production equipment. 29 crystal transmitters, 35 room, 32 telephone, 15 subcarrier, countermeasures and much more. Request a free detailed explanation sheet of contents. **PRICE:** $65 + S&H $6. **SHEFFIELD ELECTRONICS CO.**, PO Box 377940-E, Chicago, IL 60637-7940. Tel: 773-324-2196. http://www.adnetmk.com/sheffield

COLLECT COMPUTERS? Sure! Start now before it's too late. Buy a Guide to Collecting Computers and Computer Collections. Send $22 (includes S&H & taxes) to Unusual Systems, 220 Samuel, Kitchener, ON N2H1R6. 519-744-2900. kstumpf@unusual.on.ca

WHAT! YOU don't have **TELECODE's NEW 1998 "HACKER CATALOG,"** yet! 125+ items. Call 520-726-2833. Surf online at http://www.hackerscatalog.com

HOW WILL HIGH DEFINITION TV implementation plans affect you? Send $5 for detailed newsletter/report. Communications Systems Labs, Dept. HDTV, 95-132 Lokihi Street, Suite A, Mililani, HI 96789.

TELETYPE MACHINES. 12 Telex model 32, 1 Telex model 35, 2 Telex model 28, 1 Siemans T100, 1 Telemode 8000, 2 Telemode 1000. Most in working condition. Best offer for the whole works, as-is, where is. Revelstoke BC. Telephone 250-837-2081

ANTIQUE RADIO CLASSIFIED. Free sample copy! Antique radio's largest-circulation monthly magazine. Old radios, TVs, ham equip., 40s & 50s radios, telegraph, books & more. Ads & articles. Free 20-word ad monthly. Subscribe today. Six-month trial: $19.95. Yearly rates: $39.49 ($57.95 by 1st Class). Foreign: write. ARC, PO Box 802-G23A, Carlisle, MA 01741. Phone: 978-371-0512; Fax: 978-371-7129; Web: www.antiqueradio.com

AVIATION ELECTRONICS

BUY, SELL, trade, avionics equipment, Collins, King, Sperry: test equipment, IFR, Litton LTN series INUs. 941-625-3222 P, 941-625-0494 F, E-Mail: avionics@afcon.net

SYNCHRO RESOLVER test sets, system analyzers, test equipment. **www.lonemtn.com**

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

PUBLICATIONS

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

ROBOTICS

PICBOT AUTOMATION controller. Single PCB with extensive I/O and sensory for home & office automation, robotics, and light industrial applications. Includes **20MHz 8-bit RISC MCU**, up to **512K SRAM & FLASH, dual H-bridge motor drivers, dual serial COM ports, stereo digital audio, 14 Darlington drivers, 6 high-current drivers, 8 LED drivers, IR remote sensor, and user prototype area with 10 PIC I/O (A/D) lines and SMT pads.** Includes an object-oriented stack-based interpreter that runs applications from any text file on a PC. Runs off any DC power source from +6V to +24V, and connects directly to PC COM port for easy programming and configuration. **Single PCB solution for mobile robot projects.** Prices from $199 quantity 1. Webo Technology, 408-690-9660. Fax 408-279-3211 www.webo.com

STEPPER MOTOR CONTROLLER: interfaces to PC parallel port, kit $19.95, with stepper motor $24.95, assembled and tested $29.95, with motor $34.95. Controls and drives unipolar stepper motors up to 50V 1 amp. Extendable stepper motor controller: controls 4 motors, extendable up to 32 motors with external cable and drivers, $49 kit, $69 assembled and tested. Controller boards require separate power supply, 5V@1A for logic and from 3 to 50V as required for a motor. Stepper motors available from $1.50 to $25. Stepper motor controller/driver ICs L297, $4.50; A3953SB, $4.75; PBL3717A, $2.50; transistors etc., at low prices. Dual voltage power supply 5V@3A and 12V@1.5A, $12. $5 shipping and handling for orders over $50. Ask for a brochure from The Cuthbert Group, 301-236-4063 or see our web site at www.cuthbertgroup.com

Cable Converters

NEW
860E, 135 channel converter with remote, ch-3 output, AFT/MFT(auto fine tuning & manual fine tuning), parental lock, HRC/STD and sleep timer

NEW
860V, 135 channel volume control converter, with remote, ch-3/4 output, AFT/MFT, parental lock, HRC/STD and sleep timer

550E, 85 channel converter with remote unit, ch-3 output, AFT(auto fine tuing), parental lock, HRC/STD, sleep timer

Refurbished 85 channel plain converter with remote,ch-3 output, auto fine tuning, HRC/STD and sleep timer --------------------- from $25

Call or Fax us for free brochures and price list

PCW CO/(310)515-5085, (310)538-3636(Fax)

COMPUTER PARTS

www.lapazusa.com

MEMORY UPGRADES

1Mx9-70 SIMM.......... $10
4Mx9-70 SIMM.......... $19
1Mx32/36-70 72-pin SIMM (4MB). $10/15
2Mx32/36-70 72-pin SIMM (8MB). $19/25
4Mx32/36-70 72-pin SIMM (16MB) $39/44
8Mx32/36 -60 72-pin SIMM (32MB) $65/72
64M(8x64) EDO/PC 100 DIMM..... $89/95

VIDEO

1MB KIT(2-256x16)2CAS SOJ/ZIP... $18/35
1MB KIT(2-256x16) 2WE SOJ/ZIP)..... $19/36

CACHE

64Kx1-15ns 22-DIP.......... $5.50
32Kx8-25/20/15ns 28-DIP.......... $3/2/2.50
64Kx8-15ns 32-DIP.......... $6
128Kx8-15/20ns 32-DIP narrow.. $12 & up
128Kx8-15/20/25ns 32-DIP wide. $12 & up

CPU

INTEL 486DX2-66 (5v) CPU.......... $30
INTEL 486DX4-100 (5v) CPU.......... $69
INTEL PENTIUM 88hz OVERDRIVE.......... $85
INTEL PENTIUM 133/166 CPU.......... $65/79

MISC. MOTHERBOARD KITS

486 M/B 100Mhz, 256K, 16MB $95.00
PENTIUM M/B 133Mhz, 512K, 32MB $195.00
* 1-year warranty on these kits

MMX ADAPTOR allows your MB to accept MMX CPU's $30.00

AMD 486DX4-100+5v ADAPTOR+CPU FAN
This kit will allow you to upgrade your old MB to a faster CPU $65.00

LBA CARD upgrade your hard drive beyond 540MB without the expense of upgrading your present BIOS $29.95

PACKARD BELL
386/486 to Pentium motherboards

PRICES SUBJECT TO CHANGE WITHOUT NOTICE -- TERMS: COD(CASH), VISA/MC -- MINIMUM ORDER $20 -- SHIPPING & HANDLING: $7 MIN.
ORDER LINE: (800) 586-4199

LA PAZ ELECTRONICS INT'L
P.O. BOX 261095, San Diego CA 92196
TEL (619) 586-7610 FAX (619) 586-1482
e-mail: lapazusa@pobox.com

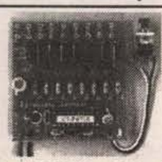
H-BRIDGE MOTOR controllers, 12VDC, 35A average, 50A peak PWM out. Forward, reverse, ramp-up and ramp-down on accelleration/decelleration. Current foldback when hot, reverse polarity protected, conformal coated, regenerative braking, compact, approx. 3.75"x5.5". $25 & S&H. 717-735-5053. http://members.tripod.com/~divelec

ROBOTS, ROBOT kits, 68HC11 microcontrollers, tutorials, software, spy cameras. Ready for Christmas! **http://www.mrrobot.com** 804-272-5752, 1-888-Mr-Robot.

CNC SYSTEMS! Write: motivity, Attn. Pam, PO Box 428, Rocklin, CA 95677. Call: 916-349-8757. Info/pictures at **www.motivityusa.com** A great place to buy CNC.

PLANS – KITS – SCHEMATICS

HOBBY CATALOG: Broadcasting and microbroadcasting transmitters, amplifiers, antennas. **Start your own radio station books.** Audio, TV, ham, CB, surveillance, science projects, and more. **PAN-COM** International, Box 130-V, Paradise, CA 95967. **www.panaxis.com**



RUNNING LIGHTS KIT. Ideal for Christmas decorations etc. 8 LEDs switch on in 10 push button selectable patterns. 8 speed levels for a total of 80 combinations. Includes PCB, parts and instructions. $14.95 + $4.95 shipping. Can operate light bulbs with 8x TRIACs ($6 extra). Amazon Electronics, tel 1-888-549-3749. Lots of other products. http://www.electronics123.com

ELECTRONIC KITS, projects and supplies for prototyping, designing or hobby. Call 1-888-GO-4-KITS for catalogs or send $3 to Quality Kits, 49 McMichael St., Kingston, ON., K7M 1M8. **http://www.qkits.com**

TEST EQUIPMENT kits. If you liked Heathkit, you will love Technology Systems, 4 Prospect Pl., Torrington, CT 06790.

HEATHKIT COMPANY is selling photocopies of most Heathkit manuals. Only authorized source for copyright manuals. Phone: 616-925-5899, 8-4 ET.

BROADCAST FARTHER! 75-110MHz amplifier connects to stereo transmitters. Produces 2-15 watts. Requires 50-150mW drive. Complete plans with part source and antenna information only $14 + $2 S&H. **Progressive Concepts,** PO Box 586, Streamwood, IL 60107. 630-736-9822.

BUILD THE MENDOCINO MOTOR. This fascinating device is a solar powered, magnetically levitated motor. It will delight and amaze you and your friends. The 27 page plans book includes a list of parts suppliers. The motor uses readily available parts. Plans are $15 plus $2.50 S&H. Write to: St. Elmo's Fire, PO Box 141, Stow, MA 01775. E-Mail: tcv@genrad.com

AWESOME KITS: voice changers, levitators, lasers, solor robots, and more! Catalog $1. **LNS Technologies,** PO Box 67243, Scotts Valley, CA 95067. www.ccnet.com/~lnstech

200+ ELECTRONICS PROJECTS. Build for pleasure or make 100% (or more) profits reselling printed plans. $1 (refundable) for catalog & dealer info. MATCO-A5, PO Box 509, ROSEVILLE, MI 48066-0509.

PCB Milling

CIRCUIT BOARDS. Totally new! Low cost, precision-made PC boards from your Gerber/NC Drill files. Single and double sided. Full details at http://www.pcbmilling.com E-Mail: feedback@pcbmilling.com FAX: 703-818-0071.

DAZZLING HOLIDAY LIGHT DISPLAY. Build a spectacular light show for the holidays driven to the tempo of your favorite music. Plans for a state-of-the-art color organ $15. Call Communications Systems Labs at 1-800-529-9483 or check our web site at **www.commsyslabs.com** for this and more,

MATCH BOOK sized FM wireless mic kit, surface mount, color enclosure included. Details: www.Nmart.com or send $9.50 check/M/O plus $0.50 S&H to Anders Corp., 104 Gray St., Paterson, NJ 07501. Satisfaction guaranteed.

TERRIFIC TIMEPIECES! LED binary clock. LED digital clocks, other kits! Free catalog! WPC, 805-339-0702. **www.west.net/~wpc**

ADVANCED TECHNOLOGY: Antigravity, free-energy, time-travel, alternative fuels, psionics, space-age weapons, lasers, ultrasonics, strange-science, bionics, high-voltage, robotics, surveillance, electronic test equipment, and more. Plans, schematics, kits. $3 for catalog: Future Horizons, Dept-N, PO Box 125, Marquette, MI 49855. http://www.futurehorizons.net/energy/

Subscribe to Nuts & Volts and be automatically entered in our monthly prize drawing!!

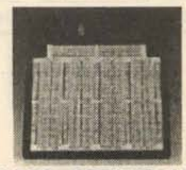
SURVEILLANCE TRANSMITTER SCHEMATICS! FM band- 2 telephone and 3 room transmitters constructed using Radio Shack parts with their numbers given. One telephone and two room transmitters are tunable from 65 to 305MHz, and constructed with listed supply house parts. PC board patterns presented. **PRICE**: $25 + S&H $2. For immediate shipment, pay with money order. **SHEFFIELD ELECTRONICS CO.**, PO Box 377940-E, Chicago, IL 60637-7940. Tel: 773-324-2196. http://www.adnetmk.com/sheffield

MOD CHIPS for Sony PlayStation. Now your backups will work. Only $9.95 ea. + $3 shipping. Call 1-888-467-6150, all major credit cards accepted. Computers & components at wholesale prices. www.cconusa.com

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

RAPID CONSTRUCTION protoboards, kits, PIC monitor chips, pocket testbench, telephone electronics. Oricom Technologies, 303-449-6428, www.sni.net/~oricom.

MYSTERY CIRCUITS THAT WORK! Challenging educational, simple technology. #10 SASE to J.H. Hughes, 445A Texas St. NE, Albuquerque, NM 87108-2395.



SOLDERLESS BREADBOARD SB-147: 3260 tie points, 4 binding posts. **$29.95** plus **$2.60** (2% of subtotal plus $2) UPS ground delivery. Call 972-242-8087 for 10+ prices. Mail check to: **CTI**, 1301 West Beltline #105, Carrollton, TX 75006.

MANUALS – SCHEMATICS WANTED

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

CASH FOR your test equipment manuals in good condition for most Tektronix, HP, Fluke, and other test equipment. E-Mail your list and best price to: **manuals@lonemtn.com**

MISCELLANEOUS ELECTRONICS FOR SALE

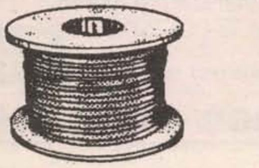
MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

SOLAR-POWERED FAN HAT. Baseball type hat with solar powered fan. Great for sports fans, golfers, etc. Available in red or blue. $19 plus $2.00 shipping. CA residents add 7.75% sales tax. Visa/MC/Disc/Amex OK. H.T. Orr Computer Supplies, 249 Juanita Way, Placentia, CA 92670. 714-528-9822, 1-800-377-2023, FAX 714-993-6216.

FOR SALE: Video tubes 13" to 32", even big radio, TV, & linear tubes. Hard-to-find TV parts, keypads, ICs, etc. Write to: 1418 Hwy. 199 S., East Dublin, GA 31027 or call 912-272-6561.

HIGH QUALITY TOOLS AND STAINLESS STEEL HARDWARE. European and American screwdrivers, nutdrivers, pliers, hex- keys, balldrivers, and more! Wiha, Bondhus, and Knipex. Stainless cap screws, machine screws, nuts, washers, U-bolts, and eyes. Free catalog. Robert Mink Import-Export, Box 6437V, Fair Haven, NJ 07704. Telephone or fax 732-758-8388. E-Mail: w2tv@csi.com

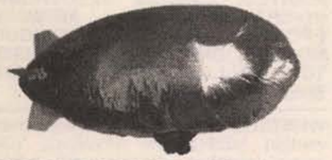
CALL FOR a free electronics catalog or visit our web site at **www.bgmicro.com/ B.G. Micro,** PO Box 280298, Dallas, TX 75228. Order line **1-800-276-2206.**



ANAHEIM WIRE PRODUCTS. DISTRIBUTOR OF ELECTRICAL WIRE AND CABLE since 1973. Items available from our stock: Hook up wire, Automotive primary wire, GXL, SXL, Plenum cable, Teflon wire, Multi-conductor cable, Irradiated PVC, SO-CORD, Mil-Spec wire, Building wire, Welding cable, Battery cable, Telephone wire, Shrink tubing, Cable ties, Connectors cut & strip to siec. If interested, please call **1-800-626-7540,** FAX: 714-771-5043. Visa/MC/Amex. SEE US ON THE INTERNET: http://www.anaheimwire.com OR E-Mail: info@anaheimwire.com

http://www.pccables.com PC CABLES and PARTS. 100s of hard-to-find new cables and parts, Free technical information, low prices, fast online ordering & browsing.

L BAND quadrifilar T/R antenna, 55 dB LNA, 20 watt HPA, works great for remote GPS. Info at afstar.com.



INDOOR R/C BLIMP. This blimp is operated by twin turbo fan unit propulsion system designed with built-in receiver and a handheld transmitter. Available in 4 frequencies. Batteries included READY TO FLY. $89.95. West Coast Blimps, 713 Cottonwood Dr., Ridgecrest, CA 93555. 760-375-2108 http://www.indoorblimps.com

SMT MANUFACTURING equipment, components, digital, analog, & RF test equipment. 26 KVA generator. Closing R&D/manufacturing company. Must sell lots of equipment. Call 1-800-869-7827 or visit www.starcom.com for list.

FREE FLYER on cable TV, phones, credit cards info, schematics, project boards, other misc. items. Bill 1-800-879-9657.

NUCLEAR ELECTRONICS (NIM, CAMAC), PMTs, optics, high vacuum, and high voltage components and equipment. Guaranteed quality at reasonable cost. OE Technologies, Box 703, La Madera, NM 87539. Ph: 505-583-2482, Fax: 505-583-9190, E-Mail: oetech@newmexico.com http://www.oetech.com

NEW, USED, and "as is" Radio Shack items. Software, printers, computers, books, parts for R/C cars, etc. Free list. B and B Enterprises, 208 S. Pulaski St., Baltimore, MD 21223. 410-566-5388.

LCD DISPLAYS, graphics 240x128 or 40 char. by 16 lines, Toshiba TLX-1301V-30L, built-in controller and RAM, optional backlite included. Directly connects to any 8 bit data bus. Full docs. New surplus, $59 ea. 650-244-9438, sales@equiptek.com

FOR SALE: (E)EPROM, PIC, 874x, 8751, PAL, GAL, PLD, DC motor, stepper, LCD and many other new and used electronics components. Call 425-489-9042, E-Mail: **esreng@jps.net**

ELECTRONICS PARTS: BELOW WHOLESALE PRICES! Phone, fax, E-Mail for free flyer. Hoffman Industries, 853 Dundee Ave., Elgin, IL 60120. Ph: 847-622-8201, Fax: 847-622-8202, toll free: 1-888-311-4248, E-Mail: hoffind@aol.com Web site & on-line catalog: http://hoffind.com

MISCELLANEOUS ELECTRONICS WANTED

MILITARY TRANSISTORS & DIODES & INTEGRATED CIRCUITS WANTED. ELECTRONIC MATERIAL INDUSTRIES 818-769-1002, FAX 818-769-1084.

TESTERS WANTED: Immediate offers made for Ultrasonic, Magnetic Particle, Eddy Current, X-Ray and Borescopes, 24hrs. Leave detailed message with make/model. 1-800-530-3371.

WANTED: ELECTRON tubes, ICs, semiconductors. Summit, PO Box 1850, Linden, NJ 07036. Call 1-800-526-4052.

WE BUY your electronic excess inventories. ICs, caps, transistors, LED, connectors, PCBs, computers and related products. Call Tom Freeman 714-558-8813, fax 714-558-1603.

WANTED: TUBE HiFi/commercial amps, preamps, corner/horn speakers. Altec, Marantz, McIntosh, Western Electric, etc. 405-737-3312 fax 405-737-3355.

WANT USED or surplus DC motor controls or adjustable frequency AC drives, 1/2 HP and up. DC motors fractional to 3 HP. C. Woodruff, 5507 55th Ave. S., Seattle, WA 98118. Voice/Fax 206-723-8487.

OLD ICs & TRANSISTORS WANTED: HIGHEST PRICES PAID please FAX your list with part number, quantity & condition of any semiconductors to Rick @ ESI, 5363 Broadway Ave., Cleveland, OH 44127. 216-441-8500 FAX 216-441-8503. Since 1946! www.electronicsurplus.com

Write in 82 on Reader Service Card.

Write in 83 on Reader Service Card.

WANTED: ELECTRONIC estates. Ham, broadcasting, military, test, public address, tubes, transformers, telex equipment. The bigger the pile, the more worthwhile. We fly anywhere. Sumner McDanel 1-800-251-5454.

BBS & ONLINE SERVICES

VISIT DON Lancaster's **GURU'S LAIR** website at **http://www.tinaja.com** PICs, pseudoscience, PostScript, patents, Tinaja quests, flutterwumpers, book-on-demand, magic sinewaves, money machines, Navicubes, tramways, wavelets, and Webmastering. Online reprints, consultants net, forums, annotated hot links, surplus bargains, great heaping bunches more.

MOD CHIPS for Sony PlayStation. Now your backups will work. Only $9.95 ea. + $3 shipping. Call 1-888-467-6150, all major credit cards accepted. Computers & components at wholesale prices. www.cconusa.com

EDUCATION

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

DON LANCASTER'S ACTIVE FILTER COOKBOOK is back in print. Autographed copies of the seventeenth(!) classic printing $28.50. **SYNERGETICS PRESS**, Box 809-N, Thatcher, AZ 85552. 520-428-4073. Visa/MC.

GRAND UNIFIED THEORY MADE EASY. 110 page book explains a new theory linking gravity, electronics & magnetism. Explores universe mysteries, goes beyond relativity & quantum theory. **$9.95**. To order: send check or M/O to American Science Innovations, PO Box 155, Clarington, OH 43915.

WANTED: SOMEONE to teach me PIC and/or single board computers. I have some knowledge, but need more! I have a project that needs stepper motor controls, among other things. Would like to find someone in the central NJ area if possible. E-MAIL: GARYBAL@AOL.COM

BUSINESS OPPORTUNITIES

MILITARY COMPONENTS wanted. Capacitors, resistors, diodes, transistors, semiconductors, ICs. Electronic Material Industries, 818-769-1002, FAX: 818-769-1084.

MILLIONS $$$ in "scrap gold" from old computers and electronics junk. Message: 603-645-4776 or www.tiac.net/users/quiksand/goldtek.htm

COUNTER SURVEILLANCE=$250 HR! Electronic eavesdropping is unbelievably widespread! Are you sure you're safe? Learn how others (without prior experience) earn **$250 HR** in the fascinating field of COUNTER-SURVEILLANCE! For FREE catalog call: **1-800-732-5000.**

PIC'n Books

LEARN ABOUT PIC16/17 MICROCONTROLLERS

EASY PIC'n — Beginner

- Programming techniques
  - Instruction set
  - Addressing modes
  - Bit manipulation
  - Subroutines
  - Sequencing
  - Lookup tables
  - Interrupts
- Using a text editor - source code
- Using an assembler
- Timing and counting
- Interfacing - I/O conversion
- Lots of examples

$29.95

PIC'n Up The Pace — Intermediate

- Serial communication
  - PIC16 to peripheral chips
  - PIC16 to PIC16
- Serial EEPROMS
- LCD interface
- Scanning keypads
- D/A conversion
- Sensors - analog voltage output
- A/D conversion
- Math routines
- Decimal interface
- PIC16F84 EEPROM data memory
- Lots of circuits and code

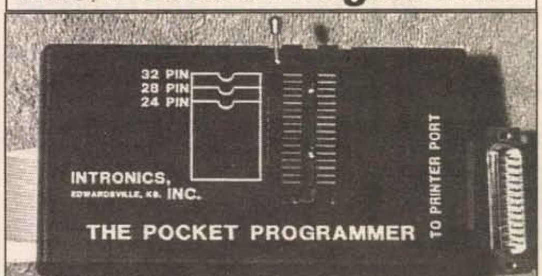
$34.95

+ $4 s/h in US for one book, $5 both books
VISA, MC, AMEX, MO, Check
CA residents please add 7.25% CA sales tax
PIC is a trademark of Microchip Technology Inc.

SQUARE 1 ELECTRONICS

P.O. Box 501, Kelseyville, CA 95451
Voice (707) 279-8881 FAX (707) 279-8883
http://www.sq-1.com
E-Mail sqone@pacific.net

The Pocket Programmer



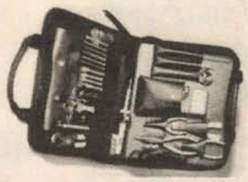
The portable programmer that uses the printer port of your PC instead of a internal card. Easy to use software that programs E(E)prom, Flash & Dallas Ram. 27(C)/28(C)/28F/ 29F/29CXXXX & 25XX series from 16K to 8 Megabit with a 32 pin socket. Adapters available for Pic, MCU's 874X, 875X, 40-Pin X 16 & Serial Eprom's, PLCC, 5-Gang, 82/74 Prom's and Eprom Emulator to 32K X 8.
Only $129.95

Same Name, Address & Phone Number for 16 Years.... Now isn't that Amazing ?

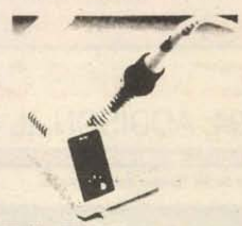
Intronics, Inc.
Box 13723 / 612 Newton St.
Edwardsville, KS 66113 — **Add $5.00 COD**
Tel. (913) 422-2094 — **Add $4.00 Shipping**
Fax (913) 441-1623 Visa / Master Charge / Amex

FOR THE BEST PRICES ON PROFESSIONAL TOOLS, CALL ELECTRO-TOOL

platt - Case - Deluxe Polypropylene. Chemical Resistant. Tools by CooperTools and others. 800T Case, complete with tools . . . **$419.95**
800T Case Only . . . **$121.80**

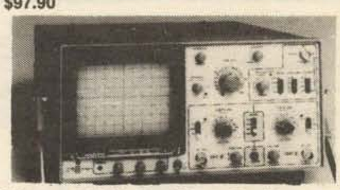


platt - Case - Cordura Exterior. Two exterior pockets & one literature pocket. 660ZT Case, complete with tools . . . **$223.00**
660ZT Case Only . . . **$59.45**
Optional Sperry meter #DM6510 as shown . . . **$65.00**



Weller WCC100- Electronically controlled station, temperature adjustable from 350°F-850°F, Zero voltage circuit-safe for sensitive components, 40 Watt pencil . . . **$97.90**

OptiVISOR - Superior magnification, Optical Glass Prismatic lenses (not plastic). Select any one of (6) magnifications . . . **$24.00**



GoldStar - 20 MHz Dual Trace Oscilloscope OS-9020A-Large 6" rectangular, high sensitivity: 1mV/div, high accuracy: ±3%, stable, low-drift design, 8 divisions of displayed dynamic range and accurate, distortion-free waveform measurements . . . **$372.00**

Electro Tool, Inc.
9103 Gillman, Livonia, MI 48150
Customer Service: (734) 422-1221
ORDERS ONLY: 1 (800) 772-3455
FAX: (734) 422-3432
"Tools American Made."

VISA MasterCard

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated **INCREDIBLE SECRET MONEY MACHINE II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. Synergetics Press, Box 809-K, Thatcher, AZ 85552. 520-428-4073. VISA/MC.

THE CASE AGAINST PATENTS. Thoroughly tested and proven alternatives that work in the real world, $28.50. **SYNERGETICS PRESS**, Box 809-N, Thatcher, AZ 85552. 520-428-4073. Visa/MC.

WHAT! YOU don't have **TELECODE's NEW 1998 "HACKER CATALOG,"** yet! 125+ items. Call 520-726-2833. Surf online at http://www.hackerscatalog.com

REPAIRS – SERVICES

PINBALL MACHINES! Books, Magazines, Manuals, Diagrams, Supplies, Parts. $2 catalog, Marco Specialties, 5290-N Platt Springs Rd., Lexington, SC 29073-9252. 803-957-5500. FAX 803-957-6974. E-Mail: tilt@ix.netcom.com http://pinballmachine.com

PICS, GALS READ if you've lost your masters. Programming service available. Call for info. Network Sales, 616-683-0500.

SERVICE REPAIR TIPS for **FREE! PROFESSIONAL BOARD LEVEL & COMPONENT LEVEL REPAIRS for TVs, VCRs, projection TVs, CAMCORDERs,** CD players, audio and other repairs on computer disk. **ADD** your repairs. **PRINT** out repairs. **BACKUP** & save **your** repairs. Want to share your repair tips? If you do, we'll send you **FREE** updates! Ask about our TIP EXCHANGE policy. For IBM compatible computers with a hard drive. Get your **FREE Stage 1 SERVICE TIPS Now! FREE CALL. CALL NOW 1-800-215-5081.**

PC BOARDS REPAIRED. Prices start at $5. Minimum 5 of one type. Network Sales, 616-683-0500.

TECH FORUM

Continued from page 44

your QB version, I was able to run it on GW-BASIC 3.20, 3.22, and 3.23 (as well as on QBASIC) with exactly the same results. (If you run it on GWBASIC 1.00 or 2.02, you will need to remove the words FOR RANDOM from the OPEN COM statement (or you will get a syntax error.)

My testing showed that the RS/Micronta-suggested GWBASIC program is structurally sound and yields consistent, identical results whether run on GWBASIC or QBASIC. Therefore, it appears that one or more parameters may be incorrect. I am suggesting five changes you can try. One change at a time:

Change

1. COM1 to COM2.

2. 1200 to 300 (also try 2400, 4800, 9600, 1800, 600, 150, 110, and 75 in place of 1200).

3. N,7,2 to N,8,2 (also try N,8,1 in place of N,7,2).

4. A$ = "D" to A$ = "d" (also try other letters A through Z, both upper and lower case, in place of D).

5. INPUT$ (14, #2) to INPUT$ (3, #2).

Change #5 presupposes that less than 14 (but at least three) characters were transmitted by your multimeter. If you do get three characters displayed (including any spaces), then you can try the other values 4 through 13.

If there are multiple incorrect parameters, it will be difficult to find them due to the large number of possible combinations. My testing did not address the possiblility of inadvertent omission of line(s)of code in the RS/Micronta-suggested GWBASIC program.

For example, the lines A$ = "D": PRINT #2, A$ seem to be a command to the meter saying 'read data.' But what if you have to initialize your meter by sending it an "I" before you can 'read data?' Or, what if you have to send it a "T" to tell it to 'Transmit' to your computer after you have 'read data?'

If none of my five suggested changes to your QB version work, then perhaps it's time to contact RadioShack/Micronta technical support.

Roger Omori
North Hollywood, CA

ANSWER TO #109810 - OCT. 1998

I do not have a schematic for parallel port to IDE, but I can point you to something very close.

Check out the GIDE (Generic IDE interface to a Z80) series of articles available in back issues (#63, 64) of *The Computer Journal.* This is by far the best technical reference to how the IDE interface works.

Check their web site or link to it from the online article "Connecting IDE Devices to 8-bit Machines" from www.blkbox.com/~jdb8042/SmallSys/8bitIDE.html.

Barry Cole
Sunnyvale, CA

ANSWER TO #11981 - NOV. 1998

The HP Paintjet Printer went out of production in 1993. According to HP, they will stop producing the ink cartridges in July 1999, but to answer your questions on the serial port and switches.

The serial port pinouts are:

Top Side

6o 7o 8o

3o 4o 5o

1o 2o

Pin#	IBM PC	MAC
1	DTR	Handshake Out
2	NC	Handshake In
3	Transmit	Data Negative
4	GND	Signal Ground
5	Receive	Data Negative
6	Transmit	Data Positive
7	NC	General Purpose In
8	Receive	Data Positive

To make the printer work with an IBM compatible, you need to twist pins 3 & 6 with 5 & 8 as these pairs compliment each other in data transmission, you also need to carry through the ground and DTR so the computer can tell if the printer is on and off.

The best way to test the printer is with DOS mode command which allows you to remap the LPT port to the desired serial port.

On = 0
Off = 1

The Switches

1 OFF	ON
7 ROM8	PC8
6 MET	ENG
5 SCS	NORM
4	A4
3	A3
2	A2
1	A1

2 OFF	ON
ROM8	PC8
MET	ENG
DTR	XON-XOFF
S4	Parity
S3	Parity
S2	Baud
S1	Baud

Baud Rate	S1	S2
9600	0	0
4800	1	0
19200	0	1
1200	1	1

Parity	S3	S4
None	0	0
Odd	1	0
Even	0	1
One	1	1

This Information is obtainable at http://hpcc923.external.hp.com/cposupport/printers/support_doc/bpd01032.html

You might also wish to try one of the following **HP support** phone numbers: **877-283-4684, 208-344-4131**, and **208-323-2551**.

You may contact me at 717-728-0833 for further assistance, or at WKM@PANETWORK.COM

Wesley K. Miller
Camp Hill, PA

ANSWER TO #11983 - NOV. 1998

Ideal Industries has two instruments for locating underground wires: the 62-120 Wire Hunter Kit and the 62-135 Underground Cable Location Kit. Both instruments will work on energized circuits.

The latter is more sensitive, and claims to detect cables up to seven feet deep or as long as 4,000 feet.

The 62-135 has a transmitter and a receiver. The transmitter outputs 447.5 KHz with a 1000 Hz modulation (presumably AM). The transmitter power is adjustable to avoid overloading the receiver and perhaps to extend battery life.

There are three methods of coupling the transmitter to the cable: direct connection with clip leads, inductive coupling with a snap-around current transformer, and inductive coupling with an antenna.

The direct connection probably consists of a step-down transformer to provide a low output impedance output at 447.5 KHz and a small series capacitor for a high output impedance at 60 Hz (so an energized line does not burn out the transmitter).

The receiver assembly appears to be a tuned ferrite rod antenna at one end of a long stick and the receiver electronics at the other. The receiver electronics probably has a tuned RF amplifier, an AM detector, a narrow 1000 Hz bandpass filter, and a speaker/signal strength meter. A receiver sensitivity adjustment allows a sensitive coarse search followed by a less sensitive fine search.

These wire locators work by detecting the magnetic field produced by the wires. The transmitter forces current to flow in the underground wires.

The transmitter frequency is high enough that even open wires will conduct current due to cable capacitance (1000 pF has a reactance of about 300 ohms at 447.5 KHz). The current flow produces a weak magnetic field, and the sensitive receiver detects that field.

Gerald Roylance
Mountain View, CA

ANSWER TO #10986 - OCT. 1998

You did not indicate the type of rotor you have, so the assumption is made that it is one of the common alliance (U-110 types) or Telex (AR-40 type) rotors.

If so, you will not be able to tell direction without the control box associated with these rotors. Both control boxes use a stepper driven directional indicator plate (with arrowed knob) to tell direction.

They usually indicate direction in five-degree increments: S-W-N-E-S clockwise rotation. They will not rotate continuously under limit switch control, beyond 360 degrees, preventing the antenna wire from wrapping around the mast.

In general, the five wires are used for the following:

Ground (1); 24V AC capacitor driven motor lead (1); Stepper magnet contact through ground (1); Motor counter clockwise limit through ground (1); Motor clockwise limit through ground (1).

Using an ohmmeter, you can identify the AC motor winding. This lead will be the only high-resistance reading, the remaining switches when closed will be 0 ohms. The AC capacitor is always located in the control box, the stepper contracts operate off of a cam in the rotor head, reversal of the direction stepper is controlled by contacts on the direction shaft arm.

Sams manuals 1191-SED, 1208-SED, 254-T10 may be able to help you and can be obtained by calling **1-800-428-7267**.

John Lippert
Menomonee Falls, WI

ANSWER TO #11988 - NOV. 1998

The problem is not with your monitor, but with your video card. There are three components in the display system: the monitor, video card, and the software driver.

A VGA monitor uses analog RGB information, so it can display an essentially unlimited number of colors, so your problem is with the video card or its driver.

Windows setup allows you to select the software driver. A driver disk usually comes with the video card. Windows also includes drivers for several manufacturers (you can get drivers from manufacturer web-sites).

Examine the video card to find the manufacturer and the model number. Windows has a generic VGA driver that should work for all VGA cards — but it may not handle the resolutions or bit depths that your video card offers.

Using the wrong driver can prevent the monitor from syncing. Selecting a mode (a combination of resolution and color depth) the video card does not support will also prevent sync.

Your VGA card may not support 256 colors — or it may not support 256 colors at the resolution you have selected. The amount of memory on the video card determines the number of colors.

By looking at the card, you may be able to determine the amount of memory. An 800x600 display (0.5 megapixel) with 256 colors (8 bits = 1byte) requires 0.5 MB of memory. If the video card has only 0.25 MB of memory, then it could only display 16 colors (4 bits = 0.5 byte).

If your video card has some empty sockets on it, then you could add more memory chips to get more colors.

An easier solution is buying a new video card — they should be less than $20.00 now.

The monitor does not limit the color depth, but it will limit the display resolution because its sync circuits have a limited frequency range.

Your monitor should support 640x480, but it may also support 800x600 and possibly even 1024x768 (SVGA). Your card may produce the correct signals, but your monitor may not support the selected resolution.

Gerald Roylance
Mountain View, CA

Continued on page 81

DEALER DIRECTORY

The dealers listed below carry the latest issue of Nuts & Volts, for your convenience.

ALABAMA
Little Professor Book Center
2717 S. 18th St.
Birmingham 35209
RT Systems
Amateur Radio Supply
8207 Stephanie Dr.
Huntsville 35802

ARIZONA
Batteries, Batteries
3415 W. Glendale Ave. #4
Phoenix 85051
1829 E. Southern Ave.
Tempe 85282
6245 E. Bell Rd.
Scottsdale 85254
Elliott Electronic Supply
1251 S. Tyndall Ave.
Tucson 85713
The Electronic Thrift Store
12329 N.W. Grand Ave. #F
El Mirage 85375
Tower Records
3 E. 9th St.
Tempe 85281

AUSTRALIA
DonTronics
P.O. Box 595
29 Ellesmere Cres.
Tullamarine 3043
www.dontronics.com

CALIFORNIA
Abletronics
9155 Archibald Ave. Unit E
Cucamonga 91730
Advanced Computer Products, Inc.
1310 "B" E. Edinger Ave.
Santa Ana 92705
All Electronics
905 S. Vermont Ave.
Los Angeles 90006
14928 Oxnard St.
Van Nuys 91411
Allen's To Go
13461 Hwy. 88
Lockeford 95237
Alltronics
2300-D Zanker Rd.
San Jose 95131
Brand Newsstand
234-1/2 N. Brand Blvd.
Glendale 91203
Centerfold International
716 N. Fairfax Ave.
Los Angeles 90046
Del Amo Books & News
3758 Sepulveda Blvd.
Torrance 90505
Electro Mavin
2985 E. Harcourt St.
Rancho Dominguez 90221
Ford Electronics
8431 Commonwealth Ave.
Buena Park 90621
Harding Way News
113 W. Harding Way
Stockton 95204
Harold's Newsstand
524 Geary St.
San Francisco 94102
HdB Electronics
2860 Spring St.
Redwood City 94063
Hi-Fi Doctor
1814 E. Ball Rd.
Anaheim 92805
HSC Electronic Supply
4837 Amber Ln.
Sacramento 95841
3500 Ryder St.
Santa Clara 95051
5681 Redwood Dr.
Rohnert Park 94928
JK Electronics
6395 Westminster Ave.
Westminster 92683
Laurel Park News
4346 Laurel Canyon Blvd.
Studio City 91604
Lion Electronic Labs
4948 E. Townsend Ave.
Fresno 93727
Netseller
7207 Arlington Ave. Ste. G
Riverside 92503
Op Amp Technical Books
1033 N. Sycamore Ave.
Los Angeles 90038
Panorama Electronics
8737 Van Nuys Blvd.
Panorama City 91402
Sandy's Electronics Supply, Inc.
20655 Soledad Cyn. Rd. #15
Santa Clarita 91351
Sav-On Electronics
13225 Harbor Blvd.
Garden Grove 92643
The Red Barn
Hwy. 299
Bieber 96009
Tower Books
211 Main St.
Chico 95928
7840 Macy Plaza Dr.
Citrus Heights 95610
1280 E. Willow Pass Rd.
Concord 94520
630 San Antonio Rd.
Mountain View 94040
1600 Broadway
Sacramento 95818
5950 Florin Rd.
Sacramento 95823
2538 Watt Ave.
Sacramento 95812
2727 El Camino Real
San Mateo 94403
Tower Magazines/News
885 Riverside Pkwy.
West Sacramento 95605
Tower Records/Video
220 N. Beach Blvd.
Anaheim 92801
2520 Durant
Berkeley 94704
212 F St.
Davis 95616
5703 Christie Ave.
Emeryville 94608
2052 Redwood Hwy.
Greenbrae 94904
6310 E. Pacific Coast Hwy.
Long Beach 90803
2280 Market St.
San Francisco 94114
3205 20th Ave.
San Francisco 94132
2525 Jones St.
San Francisco 94133
871 Blossom Hill Rd.
San Jose 95123
1205 W. Covina Pkwy.
West Covina 91790
Video Electronics
3829 University Ave.
San Diego 92105

CANADA
Com-West Radio Systems Ltd.
48 E. 69th Ave.
Vancouver, BC V5X 4K6
Muir Communications Ltd.
3214 Douglas St.
Victoria, BC V8Z 3K6

COLORADO
TH Electronics
216 Commerce Dr., Unit 2
Ft. Collins 80524
Tower Records/Video
2500 E. 1st Ave.
Denver 80206
Western Test Systems
530 Compton #C
Broomfield 80020

CONNECTICUT
Archway News
64 Bank St.
New Milford 06776
Electronic Service Products
437 Washington Ave.
North Haven 06473

DELAWARE
Newark Newsstand
70 E. Main St.
Newark 19711

DISTRICT OF COLUMBIA
Tower Records
2000 Pennsylvania Ave.
Washington 20006

FLORIDA
Alfa Electronic Supply
1502 S. St. Rd. #7
Hollywood 33023
Al's News
8219 S.W. 124th St.
Miami 33156
Bob's News & Books
1515 S. Andrew Ave.
Fort Lauderdale 33316
Clarks Out of Town News
303 S. Andrews Ave.
Fort Lauderdale 33301
Mike's Electronic Distributing Co.
1001 N.W. 52nd St.
Fort Lauderdale 33309
Skycraft Parts & Surplus, Inc.
2245 W. Fairbanks
Winter Park 32789
Sunny's At Sunset, Inc.
8260 Sunset Strip
Sunrise 33322

GEORGIA
Tower Records
3400 Around Lenox Dr.
Atlanta 30326

HAWAII
SolarWorks!
525 Lotus Blossom Ln.
Ocean View 96737
Tower Records
4211 Waialae Ave.
Honolulu 96816
611 Keeaumoku
Honolulu 96814

IDAHO
The Current Source
5159 Glenwood
Boise 83714

ILLINOIS
City Newsstand
4018 N. Cicero
Chicago 60641
Tower Records/Video/Books
383 W. Army Trail Rd.
Bloomingdale 60108
2301 N. Clark St. #200
Chicago 60614
1209 E. Golf Rd.
Schaumburg 60173

INDIANA
Harbourtown Sales
108 Park 32 W. Dr.
Noblesville 46060

KANSAS
Hollywood At Home
9063 Metcalf Ave.
Overland Park 66212
Lloyd's Radio & Electronic, Inc.
220 W. Harry St.
Wichita 67213

LOUISIANA
Lakeside News
3323 Severn Ave.
Metairie 70002

MARYLAND
Silicon Valley Electronics
2014-A Industrial Dr.
Annapolis 21401
Tower Records/Video
2566 Solomons Island Rd.
Annapolis 21401
1601 Rockville Pike #210
Rockville 20852

MASSACHUSETTS
Full Spectrum Communications
244 Essex St.
Salem 01970
Newsbreak, Inc.
579 G.A.R. Hwy. Rt. 6
Swansea 02777
Tower Records #172
360 Newbury St.
Boston 02115

MICHIGAN
Little Professors Book Center
22174 Michigan Ave.
Dearborn 48124
MW Electronics
229 E. Michigan Ave.
Paw Paw 49079
Purchase Radio Supply, Inc.
327 E. Hoover Ave.
Ann Arbor 48104
Tower Records
1214 S. University Ave.
Ann Arbor 48104

MINNESOTA
Radio City, Inc.
2633 County Road 1
Mounds View 55112

MISSOURI
Accurate Instruments
11201 E. 24 Hwy.
Independence 64054
Electronics Exchange
8644 St. Charles Rock Rd.
St. Louis 63114

NEVADA
Amateur Electronic Supply
1072 N. Rancho Dr.
Las Vegas 89106
Less Buster's Electronics
2930 N. Las Vegas Blvd.
VSTG-22
North Las Vegas 89030
Radio World
1656 Nevada Hwy.
Boulder City 89005
Tower Records/Video
4580 W. Sahara Ave.
Las Vegas 89102
6450 S. Virginia
Reno 89511

NEW JERSEY
Sys-Com
707 22nd St.
Union City 07087
JR Tech Systems
1309 Hwy. 71
Belmar 07719

NEW MEXICO
Newsland Bookstore
2112 Central S.E.
Albuquerque 87106

NEW YORK
All Phase Video Security, Inc.
70 Cain Dr.
Brentwood 11717
Goldcrest Electronics
480 St. Paul St.
Rochester 14605
Ham Central
3 Neptune Rd.
Poughkeepsie 12601
Hirsch Sales Corporation
219 California Dr.
Williamsville 14221
Tower Records/Video
105 Old Country Rd.
Carle Place 11514
350-370 Route 110
Huntington 11746
1961 Broadway
New York 10023
383 Lafayette St.
New York 10003

OHIO
Compustuff
241 Great Oaks Trl.
Wadsworth 44281
Digital One
7603 Mentor Ave.
Mentor 44060
Footsteps
4925 Jackman Rd. Store #58
Toledo 43613
Hosfelt Electronics, Inc.
2700 Sunset Blvd.
Steubenville 43952
Keyways, Inc.
611 S. Main St.
Miamisburg 45342
Leo's Book Shop
330 N. Superior St.
Toledo 43604
Powermaxx, Inc.
1587 U.S. Route 68 N.
Xenia 45385

OKLAHOMA
Steve's Books & Magazines
2612 S. Harvard
Tulsa 74114

OREGON
News & Smokes
2295 W. Main St.
Medford 97501
News & Smokes #8
259-C Barnett Rd.
Medford 97501
Norvac Electronics
7940 S.W. Nimbus Ave. Bldg. 8
Beaverton 97005
960 Conger
Eugene 97402
1545 N. Commercial N.E.
Salem 97303
Powell's Technical Bookstore
33 N.W. Park
Portland 97209
Taylor News & Books
133 W. Main, Ste. 102
Oklahoma City 73102
Tower Books
1307 N.E. 102nd Ave.
Portland 97220

PENNSYLVANIA
Bedford St. News
308 Bedford St.
Johnstown 15901
Genes Books, Inc.
King of Prussia Plaza
King of Prussia 19406
Lehman Scientific
2997-F Cape Horn Rd.
Red Lion 17356
Montco Electronics & Computers
2555 Industry Ln. Ste. D
Norristown 19403
Penn Electronics
2310 A Walnut St.
Harrisburg 17103
Surplus Al
RR 1 Box 337
Hunlock Creek 18621
Tower Books
425 South St.
Philadelphia 19147
Tower Records
340 W. Dekalb Pike
King of Prussia 19406

SOUTH CAROLINA
555 Electronics
5646 Farrow Rd.
Columbia 29203

TENNESSEE
Tower Books
204 W. End Ave.
Nashville 37203

TEXAS
BDL News, Inc.
809 Pierce
Houston 77002
Electronic Parts Outlet
3753-B Fondren Rd.
Houston 77063
Mouser Electronics
958 N. Main St.
Mansfield 76063
Tanner Electronics
1301 W. Beltline #105
Carrollton 75006
Tower Records
2403 Guadalupe
Austin 78705

VIRGINIA
Satellite Headquarters
7920 Timberlake Rd.
Lynchburg 24502
Tower Records/Video/Books
4110 W. Ox Rd. #12124
Fairfax 22033
1601 Willow Lawn Dr.
Richmond 23230
8389 E. Leesburg Pike
Vienna 22182

WASHINGTON
A-B-C Communications, Inc.
17541 15th Ave. N.E.
Seattle 98155
Bohica Concepts
214 2nd St.
Morton 98356
Cody Books Ltd.
1125 Fir Ave.
Blaine 98230
Service Request
3304 W. Rowan Ave.
Spokane 99205
Supertronix
18650 68th Ave. S.
Kent 98032
Tower Books
10635 N.E. 8th St.
Bellevue 98004
20 Mercer St.
Seattle 98109

WISCONSIN
Amateur Electronic Supply, Inc.
5710 W. Good Hope Rd.
Milwaukee 53223
Greenfield News & Hobby
6815 W. Layton Ave.
Greenfield 53220
Cudahy News & Hobby Ctr.
4758 Packard Ave.
Cudahy 53110

HOW TO PLACE A CLASSIFIED AD

TYPE or PRINT your **ELECTRONICALLY RELATED** ad copy **CLEARLY (not all caps)** on a separate piece of paper. Spell out words when submitting handwritten copy. Calculate the number of words and multiply it by the appropriate rate (see RATE PER WORD section). Include any charges for **bold** and/or CAPPED words, any artwork costs that would be applicable, and/or costs for boxing your ad (explained below). Choose the appropriate classification for your ad(s) to appear in (see below). If no classification is indicated, it will be placed in Misc. Electronics or wherever we deem most suitable. **Enclose your name, address, phone number, and *Nuts & Volts* account number from your mailing label** (if available) for identification purposes. Include full payment — **CLASSIFIEDS RUN ON A PRE-PAID BASIS ONLY** — and mail your completed order to:

NUTS & VOLTS MAGAZINE, 430 Princeland Ct., Corona, CA 91719.

RATE PER WORD

The ad rate for **current PAID subscribers** is **60¢** per word. All others pay **$1.20** per word. There is a **$9.00 minimum** charge per ad per insertion.

WORDS IN BOLD AND/OR ALL CAPS

Words to be set in **bold** or CAPS are each 10¢ extra PER WORD. **BOLD CAPS** are 20¢ extra per word. The first two words of each ad are bold capped at no charge. Indicate bold words by underlining. Words normally written in caps (e.g., IBM) and accepted abbreviations such as VAC or MHz are NOT charged as all cap words. Use a two-letter abbreviation for states.

PHOTOS, DRAWINGS, AND BOXES

A photo or drawing may be run at the top of your classified ad for an additional **$10.00** (1" depth max.) for camera-ready art. No wording is allowed in this area. Add a one-time charge of **$5.00** to enlarge, reduce, or duplicate line art, or **$8.00** for halftone of photographs. To **BOX** your ad, include an additional **$50.00** for copy-only ads, or **$75.00** for ads with art or photos.

FAXING IN AD COPY

You may fax in ad copy or changes before the closing date (5:00pm on the **5th**) at 909-371-3052 using MasterCard or Visa. Include credit card expiration date, the name that appears on the card, a daytime phone number, and your *Nuts & Volts* account number. Ads without credit card information will not be listed as received until payment is received in full. **WE DO NOT CALL OR FAX BACK VERIFICATION OR QUOTES OF FAXED-IN ADS.** For verification of faxed-in ads, please call 909-371-8497.

DEADLINE

Prepaid ads received by 5:00pm on the **closing date (5th of the month)** will appear in the following month's issue. Ads postmarked through the **5th**, but received after the closing date, will be placed in the next available issue. No cancellations or changes after the 5th. Cancellations and changes must be submitted in writing.

IMPORTANT INFORMATION

All classified ads are running copy only. No special positioning, centering, dot leaders, extra space, etc. is allowed. All advertising in *Nuts & Volts* is limited to **electronically related items ONLY**. All ads are subject to approval by the publisher. We reserve the right to reject or edit any ad submitted. We do not take ad copy or changes over the phone. We do not bill for classified ads. Repeat ads or ads run in multiple classifications within the same issue are allowed. Paid subscribers may run ads at the 60¢ rate only through their subscription expiration date. **NO REFUNDS**. Credit only. No credit for typesetting errors will be issued unless you *clearly* print or type your ad copy.

Choose a category for your ad from the classifications listed below.

- 10. Ham Gear For Sale
- 20. Ham Gear Wanted
- 30. CB/Scanners
- 40. Music & Accessories
- 50. Computer Hardware
- 60. Computer Software
- 70. Computer Equipment Wanted
- 80. Test Equipment
- 85. Security
- 90. Satellite Equipment
- 95. Military Surplus Electronics
- 100. Audio/Video/Lasers
- 110. Cable TV
- 115. Telephone/Fax
- 120. Components
- 125. Microcontrollers
- 130. Antique Electronics
- 135. Aviation Electronics
- 140. Publications
- 145. Robotics
- 150. Plans/Kits/Schematics
- 155. Manuals/Schematics Wanted
- 160. Misc. Electronics For Sale
- 170. Misc. Electronics Wanted
- 175. BBS & Online Services
- 180. Education
- 190. Business Opportunities
- 200. Repairs/Service

ADVERTISER'S INDEX

FIND what you need . . . FAST

BY PRODUCT OR CATEGORY

I'll bet there isn't a single reader of *Nuts & Volts* who isn't addicted to the nitty-gritty of whipping up a new circuit at the workbench. Soldering, etching, loading circuit boards, wiring, and even troubleshooting are the passions of just about all of us electronics aficionados. And, yet many builders shy away from mastering the one aspect of our craft that the layperson notices first: making the thing look nice.

noticed how common rack-mounted equipment is. There's a good reason for this. Rack panels and rack mounts have been standardized by the Electronic Industries Association (EIA). This guarantees that you can mix and match gear, and it'll always fit properly within your cabinets.

Virtually all pro-equipment comes this way. As it turns out, fabricating nice-looking rack panels is actually fairly painless and less expensive than you might imagine.

I can't begin to count the times I've seen a wonderfully designed circuit tossed together helter-skelter into some tattered box with labels looking like they were done by a kindergartner with a crayon!

Secrets of Making Attractive Rack Panels

by Thomas Henry

I can't begin to count the times I've seen a wonderfully designed circuit tossed together helter-skelter into some tattered box with labels looking like they were done by a kindergartner with a crayon! There's no call for this slipshod approach, if you know the secrets.

This article, then, addresses the problem of making your projects look fabulous, and reveals practical techniques developed over the course of 20 years.

There are many different ways to house your creations. But if you've been involved in electronics for any length of time, then you will have

So, let's dive right in and learn all about it.

RACK PANEL BASICS

As mentioned above, the EIA has specified a standard set of dimensions for rack-mounted gear. These measurements are spelled out in a document entitled, "Racks, Panels, and Associated Equipment," which has been given the reference number of RS-310. (A letter appended to this reference number indicates the current revision of the specification.) If you'd really like to read this document for yourself, you can probably find it at a local engineering college library. However, it's not exactly the most lively prose in the world! So, we'll extract the pertinent information here and present it in a more user-friendly fashion. In fact, we'll rely heavily on illustrations to make the details even simpler to grasp.

Standard rack panels are 19 inches wide, but the heights can vary. These heights are specified by the term "unit" or more simply by the symbol "U," which is nothing more than an increment of 1-3/4 inches. So, a 1U panel is 1-3/4 inches high, a 2U panel is 3-1/2 inches high, and so on. See Figure 1.

By the way, one of the reasons the RS-310 document is so tedious to read is that the authors have worked in some "slop factors." As an example of the language you'll encounter there, a 1U panel is dictated to have a height of 1.750-0.031 inches. What this is really saying is that a mass-produced item should be just a little less than perfect. The idea is that if you mount a bunch of these guys next to each other, you want to shave them down a bit so that your cabinet doesn't burst at the seams as you plop them in.

Since we're handcrafting our panels (not mass-producing them), we can be a little more exacting and careful. Hence, all of the measurements used in this article are precise, and completely bypass the "slop factor."

As intimated earlier, you'll be securing rack panels into some sort of overall enclosure. The EIA spec indicates that the mounting holes in the rack panel can be either a "closed slot" (an oval hole) or an "open slot." We'll use open slots since making them only requires commonplace tools like a drill, hacksaw, file, and so on.

Rack panels bolt or screw onto the side railings of a rack cabinet. The railings may be nothing more than one inch by one inch pine strips if you're using wood screws to secure the panels, or might be more sophisticated metal strips tapped to accept 10-32 machine bolts. The mounting holes are separated from each other alternately by 1/2 inch and 1-1/4 inch spacings as shown in Figure 2. A moment's reflection should convince you that this arrangement can handle any combination of standard rack panels.

Figures 1 and 2 give us all of the basic theory we need; let's put the theory into practice!

MEASURE TWICE AND ...

The number one secret of making attractive rack panels can be summed up in a single word: planning. In the old days (i.e., more than 10 years ago), this meant hauling out the mechanical pencil, T-square, and draftsman's triangles. You would then come up with some sort of a layout on a large piece of butcher's paper and hope for the best before your

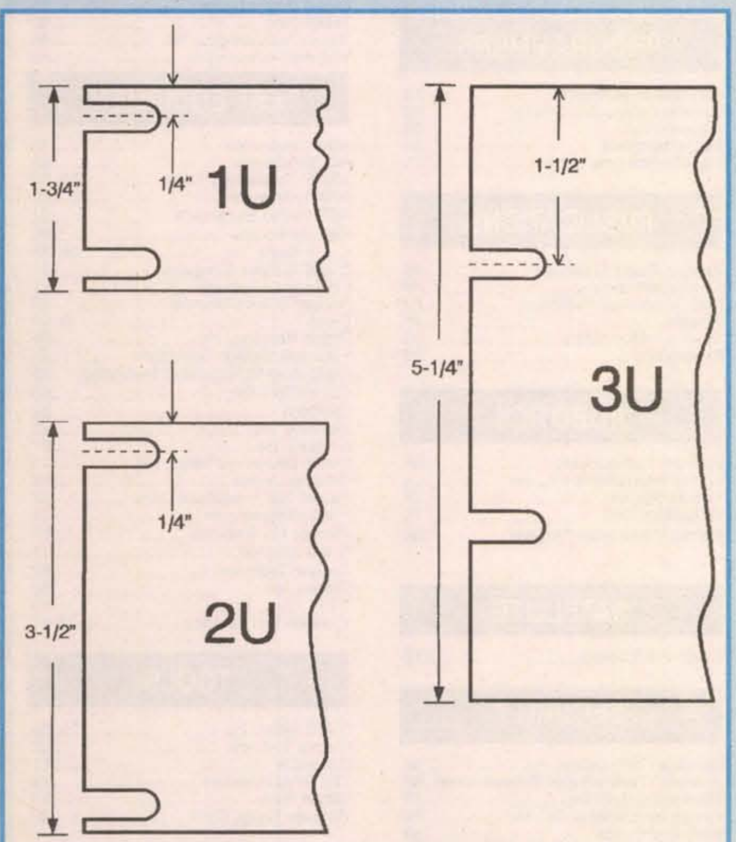


FIGURE 1: Rack panels are always 19" wide, but vary in height by increments of 1-3/4" (called a unit or simply "U"). The three most common are the 1U, 2U, and 3U panels, shown here along with their respective notch spacings. Larger panels follow the same pattern. For example, the next two would be 7" and 8-3/4" in height. The notch spacing from the top and bottom edges is 1/4" for the 1U and 2U panels, and 1-1/2" for the larger panels.

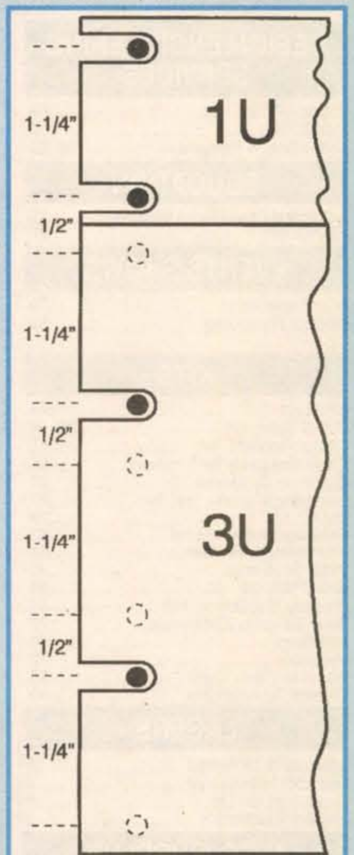


FIGURE 2: This figure depicts a portion of a rack mount with two different sized panels installed. Notice how the mounting holes, alternating at 1/2" and 1/4" spacing, accommodate the two panels. In fact, this arrangement can handle any combination of standard rack panels, no matter what their respective heights.

FIGURE 3: With a computer artwork or drafting program, lay out your front panel as in the example shown here. Use reasonable representations of the knobs, switches, jacks, LEDs, and so forth so that you can get a feel for the "ergonomics" of the panel. Allow plenty of finger room between the various controls.

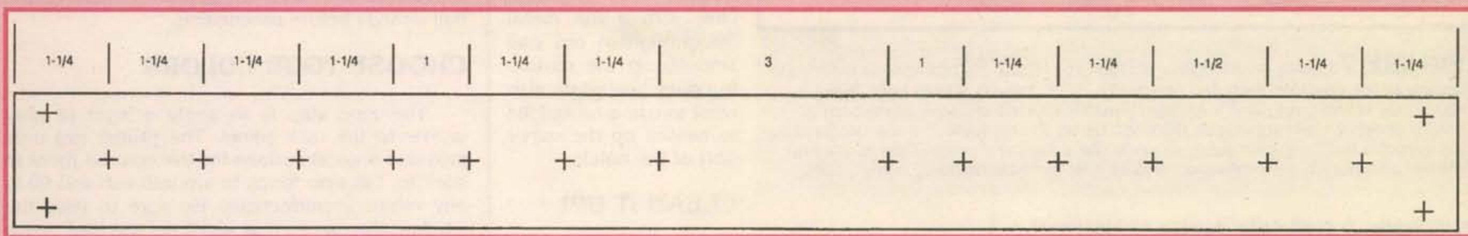


FIGURE 4: Once you are happy with your panel design (see Figure 3), replace the representations of the controls, switches, jacks, etc., with cross-hairs, as shown here. This then becomes your drilling guide. If you print it out full-size, you can attach it directly onto a raw panel with masking tape. Use a metal punch to tap a starter divot at the center of each cross-hair, which will keep the drill bit from "walking."

eraser wore out.

Nowadays, of course, we can use the computer to make things really fly along. So, boot up your favorite artwork or drafting program and start planning now! There's scads of drafting software out there (just do a quick search on the Internet and see), but be sure to pick a program that is accurate, includes alignment grids, and can easily place or center geometrical objects.

My number one choice is GeoDraw, which is part of the Geoworks Ensemble package. It's fast, small, and produces superior scaled or 1:1 hardcopy on just about any printer. If this appeals to you, too, check around the World Wide Web where you'll find many links to the program.

So, with your software running and your mouse all warmed up, start trying out some sample rack panel layouts. You'll probably want to have the actual knobs, switches, and other control paraphernalia nearby so that you can check on the spacings. Figure 3 gives you an idea of what you're shooting for. Use lifesize dimensions if your drafting program permits it. This lets you adjust the "ergonomics" as required.

For example, in my own work, I always allow 1-1/4 inches between potentiometer knobs; this leaves plenty of room for your thumb and finger to twiddle a knob without bumping into the next one. Mini-toggle switches are smaller, as are phone jacks, so only one inch is needed to separate these from their neighbors. By the way, all of your projects will benefit if you choose a standard set of "separation dimensions" and use them consistently.

This is also the time to start putting the panel legends or labels into place. Assuming your drafting software has the capability, experiment with different type styles and fonts. Arrange the labels on the layout as though this were the actual unit. Again, using a lifesize representation makes things simpler, since you can tell beforehand if the knobs or mounting nuts will foul up or obscure the lettering. Take an extra moment to look over Figure 3 once again, which illustrates these concepts. (This is an actual layout from one of my designs.)

Once you are happy with your layout, print it out full-size and examine it from a variety of angles. Since rack panels are 19 inches long, this implies that things will be simpler if you print the hardcopy lengthwise down a continuous sheet of tractor feed paper. But if you're using a laser printer with single sheet feed, you can always tape successive pages together. In any event, spend some time now convincing yourself that the layout looks right.

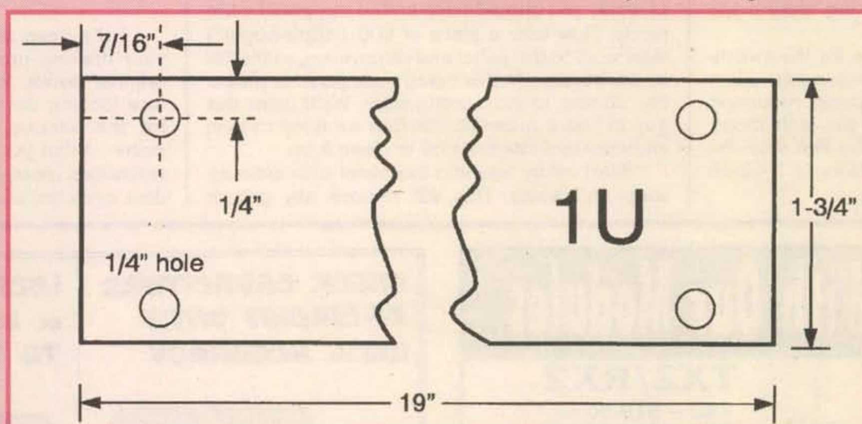


FIGURE 5: The first step in notching a rack panel is to drill 1/4" holes in the four corners. The alignment of the holes is always 1/4" or 1-1/2" from the top or bottom edges (see Figure 1 for details). The 1U panel shown here has its holes 1/4" from the edges.

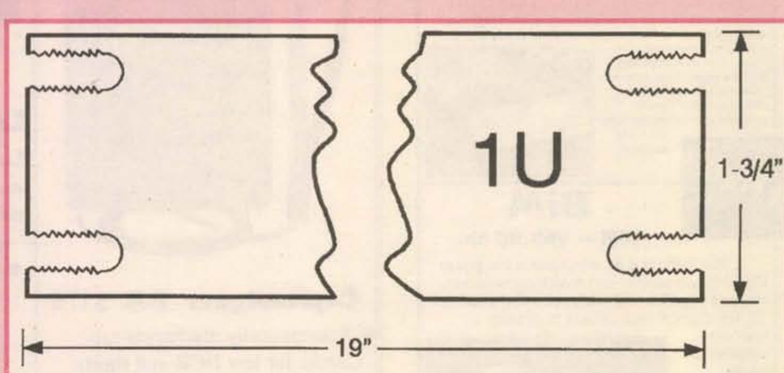


FIGURE 6: Next, the slots are cut out roughly using a hacksaw. Be sure to make them slightly smaller than required. Then with a flat metal file, smooth out the cuts and enlarge the slots appropriately. Keep them neat, straight, and free of burrs.

... DRILL ONCE

If you like what you see, then save your design to disk. Now make a copy of it with a new name. Alter this copy by replacing the various controls, switches, etc., with cross-hairs showing the center points of each. This becomes your drilling template. Figure 4 gives the general idea.

Now, print this version out lifesize. With scissors or a razor knife, cut out the entire drawing and secure it to a blank rack panel using masking tape. With an ordinary metal punch, tap divots into the center of each set of cross-hairs. The starting divot is essential when you begin drilling; this will guide the drill bit confidently and keep it from skating all over the place. When you've completed punching the divots, remove the template sheet and discard it.

And this is probably a good time to pause and say something about the blank rack panel mentioned above. If you check the catalogs, you can find a number of mail order houses willing to supply you with painted and/or punched rack panels in either steel or aluminum. First off, avoid the steel ones completely — your drill bits and hacksaw will thank you! Aluminum panels, 1/8-inch thick, are plenty sturdy and yet easy to work with.

Next, the prices demanded for painted or punched panels will alarm you so much that you might suspect they've been cast in gold! Instead, go for a completely blank panel, 19 inches wide by whatever height you require. You'll cut your own mounting notches and save money, and by painting the panel yourself, you'll not only save again, but get to choose the color scheme you like best. By the way, don't be concerned if the raw panel has surface blemishes or oxidation on it; a later step will clean these up

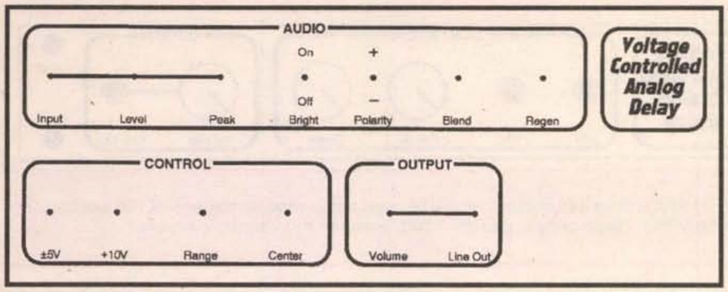


FIGURE 7: Using your original design (see Figure 3), replace the representations of the controls, switches, jacks, etc., with dots, as shown here. Make a hard copy of the page, and then have your local printing house photocopy it onto a sheet of clear stick-back material. Using a razor knife, cut the decals out. Remove the backing, then apply them to the drilled and painted panel. Line-up the decals properly by centering the dots over the various holes in the panel.

completely. A mail order source of inexpensive blank rack panels is listed in the Resources.

But back to the workbench. You're all set to start drilling the holes required by the project. Your first step should be to drill pilot holes in the center of each of the divots you punched earlier. A small bit, like a 3/32 inch, is good for this. And be sure to secure the rack panel firmly in place to a piece of scrap lumber using a C-clamp before beginning to drill. Once the pilot holes are in place, you can then drill the actual control fittings; the pilot hole will keep the larger bit centered and preclude it from walking around the panel.

So, you've now got the holes for the switches, pots, LEDs, and other components taken care of. What about the rack panel mounting slots? Another 15 minutes will dispatch these. Refer to Figure 5 which shows the first step. As illustrated there, you begin by drilling a 1/4-inch hole in each of the four corners.

Then, with a hacksaw, cut notches into the four holes you just drilled. (A workbench vise is a great aid here.) Figure 6 gives the general idea. These will be a little rough around the fringes, and so should be sawed just a trifle smaller than required. Now with a flat metal file, straighten out and smooth up the mounting slots. You might also want to use a rat tail file to neaten up the curvy part of the notch.

CLEAN IT UP!

Well, if everything has gone according to schedule you now have an aluminum panel fully cut and drilled to accept the various controls and switches. And the mounting slots permit it to be slipped into a cabinet for permanent use. The only trouble is that the front surface is a bit scuffed here and there, and other blemishes may detract from the general appearance. That's easy to deal with!

Slip a piece of fine grit sandpaper into an electric sander and have at it! After three minutes of work, you should have buffed the panel quite nicely. Now take a piece of 000 ("triple-aught") steel wool to the panel and remove any swirls left by the sander. At this point, your panel is probably starting to look pretty silky. We'll paint this guy in just a moment, but first we need to take an important intermission to clean it up.

Start off by washing the panel with ordinary soap and water. This will remove any grit or debris left from the sanding and steel wool steps. Really suds it up well, and rinse it thoroughly afterwards. Give the panel a quick dry off with a soft towel.

We need to get rid of any remaining soap film or residue now. So, using cotton balls and 90% alcohol (available at any drug store), give the panel a thorough cleansing. The alcohol will remove any lingering soap scum completely. Let the panel air dry, then buff it down one more time with a soft, dry towel. Check for any lint or cotton ball strands before proceeding.

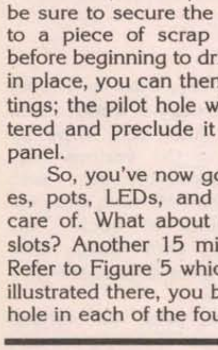
CHOOSE YOUR COLORS

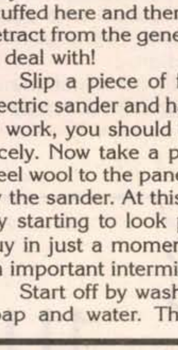
The next step is to apply a layer of gray primer to the rack panel. The primer not only provides a good surface for the colored paint to stick to, but also tends to smooth out and fill in any minor imperfections. Be sure to read the label on the can so that you'll get the best possible results out of the gray primer.

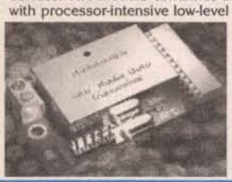
Once the primer is dry, you can apply the colored spray paint layer. The top choice here is probably epoxy paint (the kind used on household appliances). Epoxy paint provides an extremely tough surface, immune to most chipping and scuffing. Again, be sure to follow the instructions on the can carefully, and allow plenty of drying time.

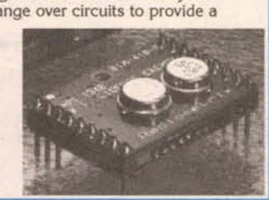
LABELING THE PANEL

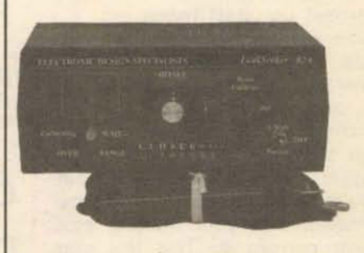
Let's head back to the computer. Boot up your drafting program again, and load in your original layout. We'll use this to whip up some nice looking decals which will provide a legend for the various controls. Figure 7 gives the details. What you do is replace all of the representations (pots, jacks, switches, etc.) with black dots centered over each fitting. The reason for











this will become clear in just a moment. Now using the "cut and paste" command within your software, rearrange the major groupings so that they'll all fit on an 8-1/2-inch by 11-inch sheet of paper. If you're satisfied with how things look, print it out, using a laser printer for best results.

Take the page to your local photocopy shop and have the folks there reproduce it onto a sheet of clear sticky-back material. (This is a self-adhesive transparent plastic sheet which comes in either shiny or matte finishes.) Alternatively, if you have a stock of blank sticky-back sheets yourself, you could run them through your laser printer directly and skip the photocopying step.

Next, using a sharp razor or X-acto knife, cut out the decals in logical blocks. For example, in Figure 7, there are four logical blocks, or you could lump the top two together and the bottom two together. In any event, peel off the backing of the decal and press it down on the panel. The dots help you line it up over the holes you've already drilled. To avoid trapping air bubbles under the decal, it's usually best to start at one end and carefully work your way along the length of the decal. Then place a sheet of paper over the decal, and with the back of your thumbnail rub it down smoothly to press out any air bubbles.

At this point the decals cover everything, including the holes! So, with a pointed X-acto knife carefully cut out the center of each one. That is, stab the knife into a hole, then slide it around the perimeter trimming away the sticky-back material. When you make it all the way around, a disk will pop out which you then discard. Repeat for all of the remaining holes.

To really protect your handiwork, you need to apply a layer of clear plastic spray paint. But here's an important point. Spray it on in many, many thin layers (allowing time to dry between each layer), instead of several thick layers. This not only keeps the "ink" from running, but also prevents swirls and runs from rearing their ugly heads.

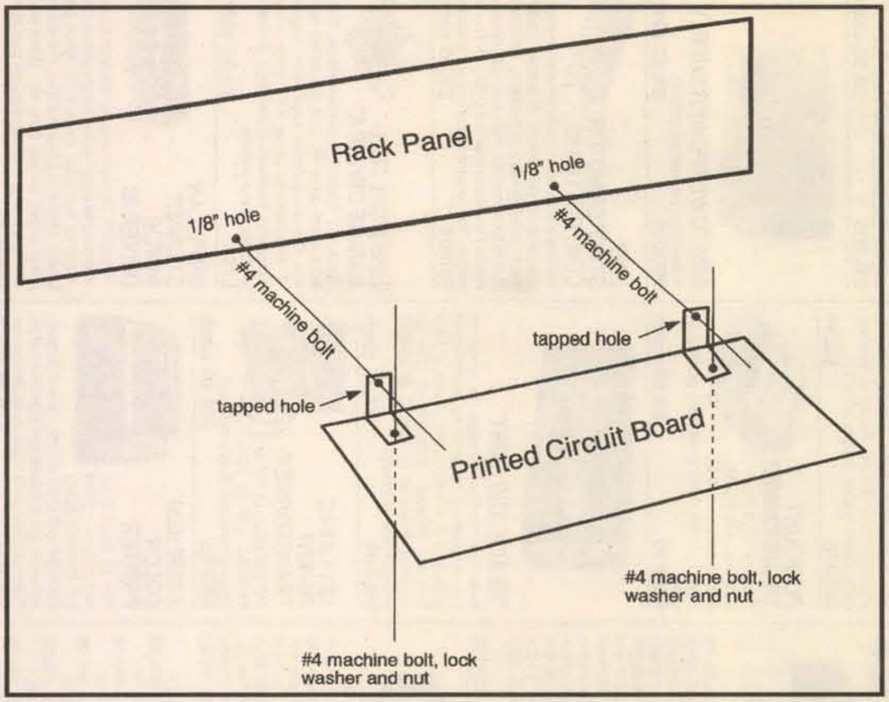


FIGURE 8: A printed circuit board mounts behind the front panel by means of two small angle brackets. The front holes of the brackets have been tapped to take #4 machine bolts, while the bottom holes accept #4 bolts, lock washers, and nuts.

USING YOUR PANEL

Give the clear coat a couple days to really dry, and then you're all set to start building with your new rack panel. For most common circuits, you can simply mount the circuit board behind the rack panel on little angles. Figure 8 illustrates how to do this. (On the other hand, RF or high-voltage circuits should probably be housed in something that isolates them completely from the outside world.)

When you're all done with the wiring and testing, you can mount the completed unit in a cabinet. As mentioned earlier, if your cabinet has wooden rails you can use wood screws for this; tapped metal rails require a 10-32 machine bolt. If you have a choice of head type, pick the oval style. That way, you can use cup washers between the screw or bolt and the front panel; the oval head "settles in" to the center of the cup washer quite nicely and looks very professional. They are available in several sizes and materials (brass, aluminum, nickel-plated, etc.) at most hardware stores.

And here's an idea I came up with to keep the cup washer from marring the front surface of the rack panel. While you're still at the hardware store, head over to the plumbing department.

There you'll find a large range of rubber O-rings (for fixing faucets and so on). I discovered that there are sizes of these that fit perfectly in the back (hollow) side of the cup washer!

Thus, when you secure the panel in place, the screw passes through the cup washer, then the O-ring, then the panel, and finally the cabinet rails. The rubber cinches everything together nicely and protects the panel from the sharp edges of the cup washer.

If you've come this far, then you now know the secrets of making truly decent-looking rack panels for your own equipment. Over the two decades that I've been using and refining this process, I have had a steady stream of compliments from people on how attractive my gear appears.

If I (with a total lack of a background in art) can do it, then so can you! **NV**

RESOURCES
BLANK RACK PANEL KITS

Blank rack panel kits are available from **Midwest Analog Products** in either 1U or 2U sizes. Each kit includes: blank aluminum rack panel, 1/8" thick tapped miniature angles zinc plated #4 machine bolts, lockwashers and nuts

#K901 1U (1-3/4" by 19") Rack Panel Kit $8.95
#K902 2U (3-1/2" by 19") Rack Panel Kit $10.95

Note the following ordering information:
Minimum order of $15.00. Please add shipping and handling of 10% of merchandise total or $5.00 (whichever is less).
Shipping is by First Class Mail.
Prices shown in US dollars. Remit US funds only. Write or E-Mail for shipping information to other countries.
MN residents add 6.5% sales tax.
Money orders and checks only.
Prices and terms subject to change without notice.
Free catalog available upon request.

Order from:
MIDWEST ANALOG PRODUCTS
P.O. Box 2101, N. Mankato, MN 56003
E-Mail: map@prairie.lakes.com
WWW: http://prairie.lakes.com/~map


Think Christmas!
TOMINON HI-POWER LENS
1:4.5, f=230mm (9"), weight 4 lbs. Six coated symmetric glass lenses in black aluminum case, 3.625"" dia. by 4.375" long. Scale range from 1:10 to 1:1 to 10:1. Originally cost over $350.00. Unused.
92L034 $29.95 each
PRECISION EYEPIECE
21mm f:3.5. Four coated lenses in black aluminum case measuring 1.5625" long by 1.0" diameter, 35° angle of view without vignetting.
92L031 $4.95 each
TELESCOPE KIT
One Tominon High Power Lens (92L034) and one Precision Eyepiece (92L031) with documentation on how to build a wide field telescope.
96L004 $35.00/set
Do It Yourself!
INFRARED KIT
Includes part #97V012 (assembled transmitter unit with forty-seven buttons), detector unit, printed circuit board, detector amplifier IC, and all parts needed to detect the signal from the transmitter and convert it to a serial TTL signal.
93V010 $19.95 each
FUNCTIONALLY-CHALLENGED SIGNAMAIL UNITS
These units don't work! What you get are three sets each consisting of one 9V, 49.xxx MHz crystal-controlled FM transmitter, and a matching dual-conversion narrow-band FM crystal-controlled receiver/tone decoder/signal unit that runs on 6VDC. With documentation.
98Z011 Three for $10.00
AMPLIFIED 3-D MULTIMEDIA SPEAKER SYSTEM
Magnetically shielded 2-way speaker system with 2" tweeter and 4" woofer. 300W P.M.P.O. 4 Ohms impedance. Frequency range 20Hz~20MHz. Power LED/surround/bass/treble/volume controls. Dimensions 226mm H x 140mm W x 175mm D.
95V014 $59.95/Pair
MEMBRANE KEYPAD
5 x 4 matrix, approx. 3" sq., with adhesive backing.
97B014 99¢
RF SNIFFER
This useful kit is a wideband RF detector that indicates RF field strength in the 100KHz to 500MHz range at low levels. The kit includes an etched and drilled circuit board and all necessary components, except 9V battery. It also comes with a plastic case, antenna and an attractive analog meter.
The RF power reading is not linear and simply indicates the presence of RF and its relative level. However, it makes a great BUG detector or you can use it to test the output of any RF transmitter, including ham radios, cordless telephones and even car alarm transmitters! The circuit has an adjustable attenuator to handle everything from low to high power levels. Use during RFI/EMI precompliance testing. The kit is easy to assemble and comes with schematic diagrams and complete instructions.
97K005 $29.00 each
UHF LINEAR AMPLIFIER
Input: 1 dB. Freq. Range: 890 to 940 MHz. Gain: 17 dB. Bias: 18 VDC @ 100 mA. Wilmanco #730.
96V001 $14.95 each
Gift for Your Family's Safety!
OKI MOBILE CELL PHONE
These new factory-boxed Oki 1200-series cellular phones are made in the USA. They have outstanding sound quality, memory to store up to 100 names and numbers you call most, ten one-touch dialing keys, and "911" dialing even when the phone is locked. They also have two NAMs to minimize your roaming charges. These phones have a user-friendly design that will mount vertically or horizontally, and the handset will mount on the dash/console. The transceiver mounts anywhere, from the trunk to under the seat. Use an external antenna for greater range.
OKI1200 $25.00 each
TWINKLING HOLIDAY ORNAMENT KIT
Ornament is 3" tall, small enough to hang on your Christmas tree or around your neck at a holiday party. Either way, it's guaranteed to attract attention.
97K006 $18.00 each
One-Pound Spool FAMOUS BRAND SOLDER
60% Sn, 40% Pb, 0.050" diameter for electronics work.
92Z013 $9.95
Other solders in stock, including rare alloys.
EXTENSION CORD AND HOLIDAY LIGHT TESTER
Indicates location of break in appliance or lamp cords, and tests all types of holiday light strands for locating defective bulbs. Safe and simple to use.
GVD-500ACS $2.49
Give your fish some fresh air!
AQUARIUM AIR PUMP
On soft rubber base, approx. 3"W x 4.25"L x 1.875"H.
94U020 $7.95 each
Super Gift!
EASY PIC'N v3.0
By David Benson
A beginner's guide to using PIC 16/17 microcon-trollers. From "Square1," 161 pp., 8.5" x 11".
98X006 $29.95
GOBS OF GOODIES!
Studioline Stereotrack II Cable TV Adapter
Separates stereo signals from the cable TV input, feeds RF signals to TV/VCR tuner and stereo signals to FM (either RF or fixed/variable level audio). Hundreds of useful parts which may be removed for audio/RF projects. Controller board has CPU and socketed EPROM as well as Mitsumi varactor tuner, cable/FM separator board, regulated power supply subassembly, channel select board, and stereo separation output board. Black metal case, 14" x 10" x 3". Sold for experimental purposes only. With documentation.
92V020 Two for $39.95
RACK MOUNT CABINETS
These high-quality rackmount enclosures come in an attractive charcoal grey epoxy finish. The top, bottom and sides have ventilation holes to assist in colling. The front and back panels are made of 0.059" thick aluminum for easy custom design. The top, bottom and sides are 0.035" steel. Choose from six sizes. All include handles except RC3120A.
RC3120A - Front panel 19" x 1.6875" 1.5"H x 16.625"W x 9.625"D - $38.00
RC3120B - Front panel 19" x 3.4375" 3.25"H x 16.625"W x 9.625"D - $46.00
RC3120C - Front panel 19" x 3.4375" 3.25"H x 16.625"W x 13.1875"D - $53.00
RC3120D - Front panel 19" x 5.1875" 5"H x 16.625"W x 13.1875"D - $58.00
RC3120E - Front panel 19" x 5.1875" 5"H x 16.625"W x 16.75"D - $63.00
RC3120H - Front panel 19" x 8.6875" 8.5"H x 16.625"W x 16.75"D - $83.00
New! Y2K!
EMERGENCY SURVIVAL COMMUNICATIONS
How to Build and Power Your System
Keys to survival news. Shortwave radio. World of amateur radio. Scanning. CB/Citizens Band. Personal communications systems. Satellite radio and guide. Alternate power sources. Free playing radios. Weather information. Radio antennas. Source lists. paper, 182pp, 8.5 x 11.
98X008 $9.95
PC MOUNT TRANSFORMER
Primary: 115/230V, 50/60Hz, 180/90mA. Secondary: 15/30VCT, 14VA. Wiring diagram printed on unit.
98N010 $4.95 each
"BLACK (UV) LIGHT"
Avon "Derma-Spec" imager designed for skin evaluation, but ideal for many other applications. Plastic case contains a UV-B bulb and reflector. Auto turn-off after 50 seconds. Powered by 12VDC @ 500mA wallwart (not included).
98L009 $7.95 each
12/14.5VAC POWER TRANSFORMER
110VAC input. 12VAC or 14.5VAC out @ 25A (tapped primary). Specs included.
98E005 $29.99 each
ATARI 1020 COLOR PRINTER
For all Atari 8-bit computers. (Not PC-compatible!)
Package includes: printer, power supply, software, pens, paper and interface cable. These are new units in factory sealed boxes.
94C037 $14.95 each
TV AUDIO DEMODULATOR
Unused unit from cable TV box takes channel 3, 4 or 5 signal and demodulates the audio. Comes with documentation and schematics, plus additional schematics to build add-on video demodulator board.
92A028 $9.95 each
Super Gift!
DELUXE KEYCHAIN LASER
High quality laser pointer sports attractive finish. Projects plain beam and four designs up to 1000 feet on three tiny LR44 1.5V watch batteries (included). Weighs in at only 0.6 OZ. 645nm 5mW, class IIIA.
98L008 $9.95 each
MINI TOWER POWER SUPPLY
Pulled from unused equipment.
96C009 $9.95 each
L297 STEPPER MOTOR CONTROLLER IC
Normal/Wave drive. Half/full step modes/Clockwise/anticlockwise direction. Switch mode load current regulation. Programmable load current. Few external components. Reset and enable inputs, and home output. Full documentation on our website.
95I004 $7.90 each
L298 DUAL FULL-BRIDGE DRIVER IC
Up to 46V operating supply voltage. Total DC current up to 4A. Low saturation voltage. Overtemperature protection. Logical "0" inputvoltage up to 1.5V (high noise immunity). Multiwatt-15 package. Docs are available at our website.
L298 $9.95 each
UNIPOLAR STEPPER MOTOR DRIVER IC
UCN5804. Drives a unipolar stepper in one of three operating modes: single phase, two phase or half step. Up to 1.25 Amps per phase. Step and direction input. Drive with a 555 timer, parallel port, etc. Build your own robot, anything that requires precision positioning.
93I002 $4.50 each
AIRPAX PULSE MOTOR
7.5°/step, 48 s/rev., 12VDC, six-wire. Airpax #LA82407, with spec sheet.
92M010 $3.95 each
COMBO PACK!
One 93I002 IC and 92M010 motor (both shown above) with schematics.
93I003 $7.95/set
Send $2.00 For Our Latest Catalog!
$4.00 Foreign. Refundable on First Order.
VISA MasterCard
Store Hours: 9-6 M-F & 10-3 Sat. - Pacific
Visa, M/C, AmEx Accepted.
All Sales Final.
California Residents Add Sales Tax.
Shipping Additional on All Orders.
Prices Good 60 Days from Date of Publication
011298
ALLTRONICS
2300-D Zanker Road - San Jose, CA 95131-1114
World Wide Web: http://www.alltronics.com
(408) 943-9773 - Fax (408) 943-9776

by Joseph J. Carr

Open Channel

Antenna Gain and Pattern Measurements

One way to characterize radio antennas is by their radiation pattern. When a signal propagates from an antenna, it radiates in some directions more than others. A theoretical construct called an isotropic source is a spherical point source that radiates in all directions. An antenna shows an apparent increase in power in preferred directions because the power that is spread over the isotropic surface is concentrated in the preferred direction. This is the gain of the antenna. The gain of an antenna in any given direction is found essentially by comparing the signal strength in that direction to the signal strength of the same unit area on the surface of the radiating isotropic source. This is called gain over isotropic, and is expressed in decibels (dB).

When we make a map of the gains in all directions, we have the radiation pattern of the antenna. The overall radiation pattern is a solid, three-dimensional geometric figure, so we often take horizontal ("azimuthal") and vertical ("elevation") slices out of the pattern and present them as representative of the whole.

Figure 1 shows the radiation pattern for unidirectional Yagi-uda array designed for 151 MHz, where it can be used for solar noise detection. Ideally, the Yagi-uda is unidirectional, but "real world" antennas are not so fortunate. In this case, there is a considerable back lobe and several sidelobes in addition to the main lobe. Any lobe in an unwanted direction results in wasted power (lower signal strength on target), greater possibility of interfering with other stations and (because of antenna reciprocity), more noise and interference on receive. Clearly, the antenna designer and user needs to know the nature of the azimuth and elevation patterns.

Outdoor Tests

Figure 2 shows an outdoor method for measuring the antenna radiation pattern. It is fraught with difficulty, but is sometimes the only means available for a particular antenna or location. Although it's best to use an indoor antenna range (discussed below), those facilities are both expensive and frequency limited. All such facilities have a lower frequency cut-off limit, below which it will not work properly.

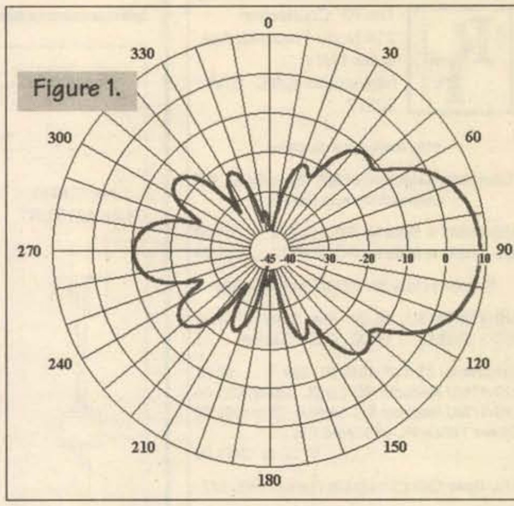


Figure 1.

In Figure 2, the antenna under test (AUT) is mounted to a rotator assembly. A distant source, perhaps a distant on-the-air radio station, is used to provide a signal source. The signal source must be in the far-field, i.e., where the power density falls off according to the inverse square law ($1/D^2$). The pattern can be obtained by rotating the antenna through a 360-degree arc, and measuring the signal strength at points along its arc of travel.

This process is easy, intuitive, and inherently appealing. But it is also problematical. For one thing, in the off-the-air variation on this theme, there is no guarantee that the output power of the distant radio station is constant during the time the antenna is rotating.

Some of the ambiguity can be taken out of the outdoor test approach by using a known reference signal, rather than an off-the-air signal. If a signal is generated, and controlled to maintain a constant output level, then part of the problem is solved. In general, the best approach to having the signal provide uniform illumination of the antenna is to radiate it from a location outside the near field of the antenna, from a transmitting loop antenna that is small compared with the wavelength of the signal being emitted. A loop that is <0.15λ has the attribute of exhibiting a constant current throughout the conductor. Larger loops, and other forms of antenna, have a varying current distribution along the length of the

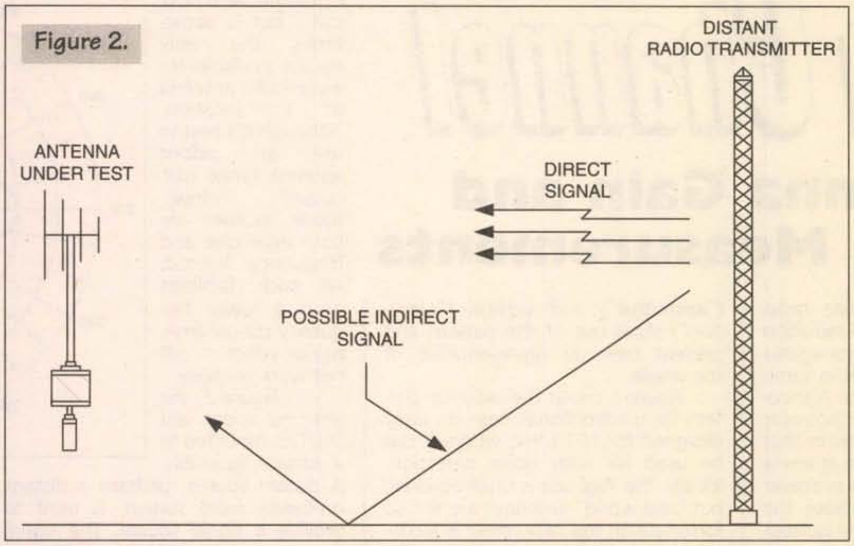


Figure 2.

1. Set S1 to measure the signal strength from the reference dipole.

2. Set S1 to measure the signal strength from the AUT (it should be higher).

3. Adjust the precision attenuator in the transmission line from the AUT until the S-meter reads exactly the same as it did for the reference dipole.

One instruction for this method took note of the fact that the signal levels might vary over time, so switching between antennas can introduce error. The problem is partially solved by switching the antenna at a slow enough rate to capture the data, and taking a large number of samples (e.g., one per second over several minutes) and averaging the results.

antenna radiator.

Also, unless it is a broadcasting station, it is likely to go on and off the air with use rather than emitting a constant signal. In the high frequency shortwave bands, this problem can be especially acute because of fading mechanisms afflicting even groundwave signals. With skywave sources (ionospheric propagation aka "skip") it is insanely difficult to account for!

Another problem is unwanted signal paths. Normally, one hopes that only the direct space wave is received. That would make the problem easier. But in real environments there may be additional paths. In Figure 2, a ground reflection is shown. It is sometimes easy to overcome these by being aware of their source and adjusting the data accordingly. Unfortunately, nice static ground reflections are not the only sort found. Especially at VHF/UHF, there may be transient reflections due to passing ground vehicles and aircraft. Supposedly, sometimes even good-sized birds can be a problem.

All in all, the outdoor method is perilous, at best. But before moving on to discussing the indoor range approach, let's take a look at a quick and dirty approach to making gain measurements.

Figure 3 shows two antennas pointed at the same distant source. It is relatively easy to achieve a reasonable approximation of the antenna gain by comparing it to a reference antenna. For most purposes, either a half wavelength dipole or a quarter wavelength vertical antenna is preferred for the reference antenna.

The basic procedure is simple and straightforward. Let's assume that the AUT has a higher gain than the reference dipole. Set S1 to measure the signal strength coming from the reference antenna. Next, switch S1 to the AUT and again measure the signal strength.

If the receiver used has the ability to accurately measure the two signal levels, then a gain determination can be made. If the receiver is merely a communications receiver with an S-meter, then there may be problems if either: a) the S-meter calibration scale factor is unknown, or b) the scale factor changes over the range (some S-meters compress the upper end of the scale, so the difference between S8 and S9 is fewer decibels than the difference between, say, S1 and S2, despite the fact that both are "one S-unit"). In that case, a modified procedure is used:

Indoor Range

If the funds and facilities are available, then an indoor antenna range (Figure 4) is preferred. The data collected are of far greater usefulness than the data collected out-of-doors, especially off-the-air. The indoor range is simply a more easily controlled, predictable environment.

The indoor range consists of a room lined with materials that absorb radiowaves. Usually in the form of pyramid-shaped wedges, various sizes of absorbers are placed over all surfaces of the chamber. The room is inside of a Faraday cage. This shielding provides protection against both signals from outside interfering with the test, and reflections of the reference signal from structures outside of the chamber. A point source, such as a small loop at UHF and below, or a horn radiator at microwave frequencies, is positioned at one end of the room.

The antenna is mounted on a rotatable pedestal. In order to

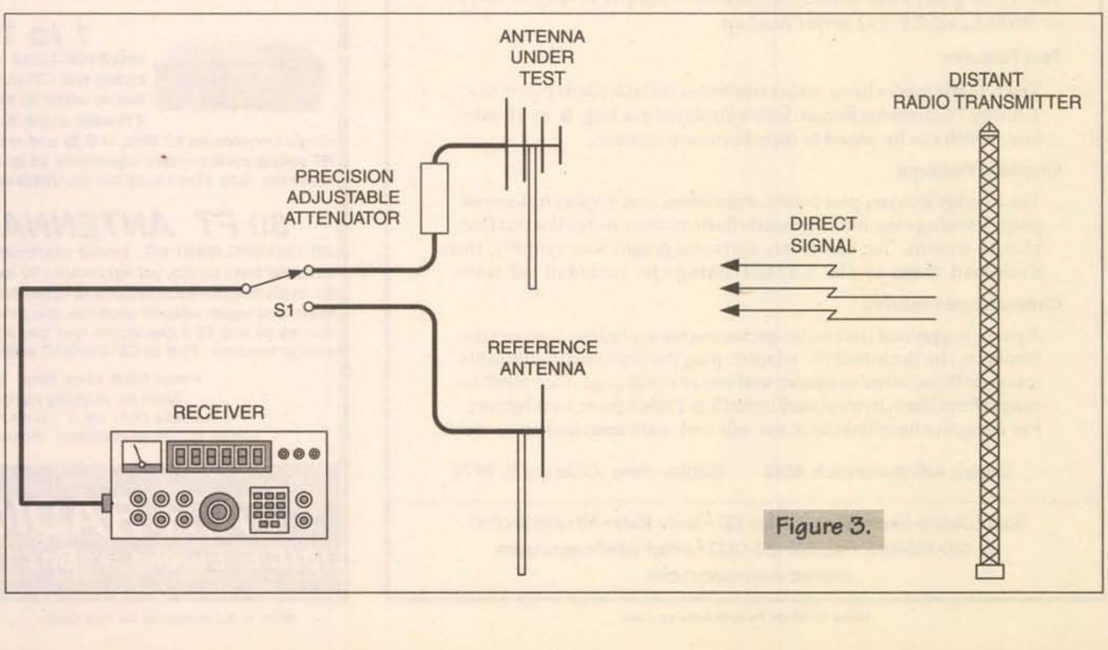


Figure 3.

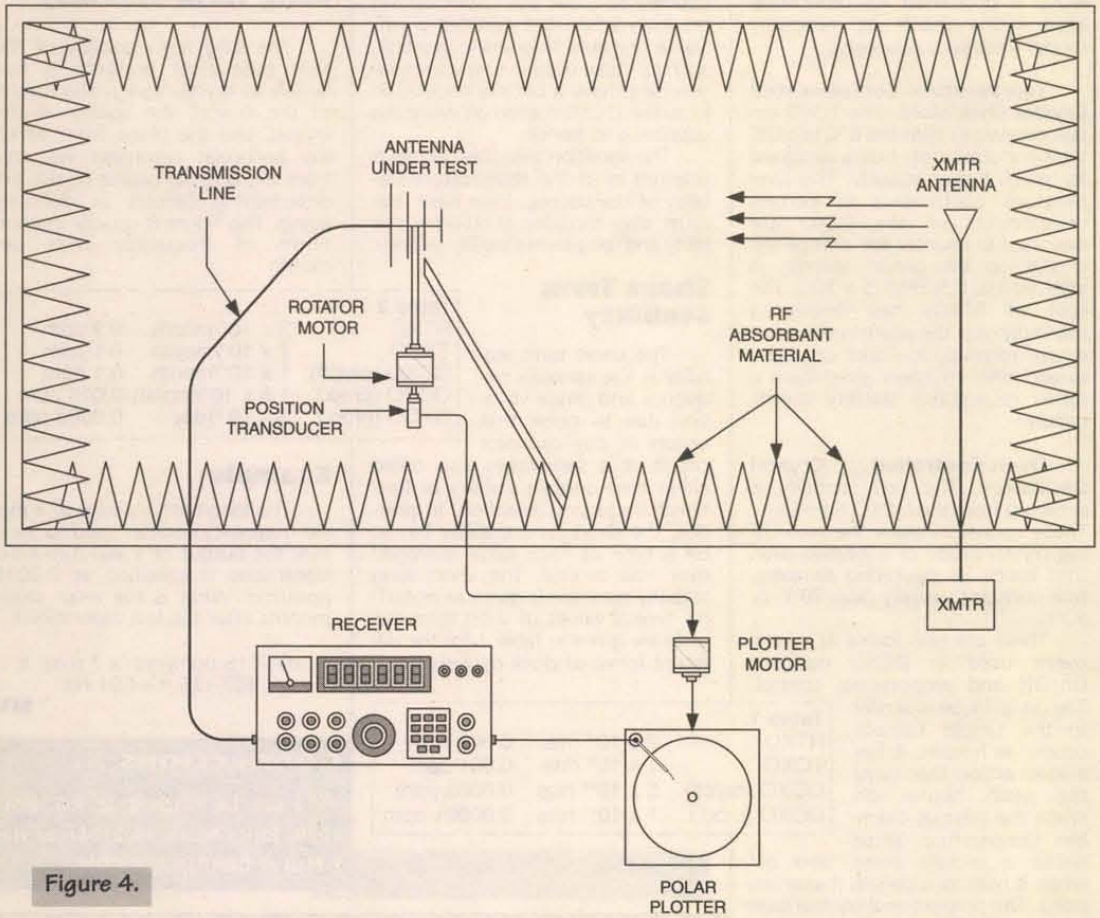


Figure 4.

prevent secondary reflections from the pedestal, it is often the case that blocks of absorbent material are used to block the view of the pedestal from the radiator. Both elevation and azimuth plots can be made by the simple expedient of mounting the antenna in the correct plane for each test.

The polar pattern of the antenna is created by using a servomotor or position transducer to rotate a chart recorder that measures the output strength of the receiver. The result is an antenna position-signal strength plot similar to Figure 1.

Modern versions of the indoor range use a computer rather than the polar plotter shown in Figure 4. The output of the receiver is a voltage indicating signal level, so it can be A/D converted for input to the computer. The position transducer can also provide data to the computer. Once these data are in, a plotting program can draw the polar plot.

One advantage of the computer approach is that a static profile of the chamber can be made by mounting a reference antenna in place of the AUT. The plot can then be made, and note taken of any reflections or other anomalies that exist in the chamber. These data can then be compared with the data for the AUT at each angle, with the AUT data adjusted to account for directional differences.

Antenna Modeling

Antenna chamber time can be expensive, so the trend today is to model the antenna performance on the computer before doing any actual building and testing. At one time, it was common to perform range tests, and then tweak the antenna design to improve the performance (often with inconsistent results). Antenna modeling provides a lower cost approach to tweaking performance, with range time reserved for final confirmation. I have discussed antenna modeling in this column in the past. My own modeling is done with the Nittany-Scientific Nec-Win Basic program.

Other Ways to Solve the Problem

There are a couple of other ways to find the antenna pattern, or at least a rough approximation of it. For many years, radio broadcasting stations were required to do "proof of performance tests" that showed the radiation pattern. As part of the initial construction of the station, they would go to specified points on a map, and measure the field strength. If enough points "all around the compass" are measured, then a rough approximation of the pattern is made.

The AM broadcast band station is one area where this must be done. Antennas are hundreds of feet high, so are not very easy to measure in chambers! Besides, the point is the "installed" behavior, not the in-chamber behavior. This same thing can be done by amateurs and others. Use a topographic map (not a road map). These are available from the US Geological Survey. They have stores in locations around the country, and their products are also sold by commercial map dealers. Locate the antenna on the map, and make a dot.

Next, take a drawing compass, and spread the arms to make a radius equal to one mile on the map. Draw a circle with the antenna location at the center. Next, pick 30 to 60 points along the circle, and then travel there and measure the signal strength. Crude? Yes, but a reasonable idea of the antenna pattern can be obtained.

Another method for measuring the antenna pattern was used by a friend of mine down in Texas. Johnnie owned a small farm (43 acres) that he used for making antenna experiments. He also owned a 1946 Taylorcraft airplane. It was a kit-built variation on the Piper Cub style design. He owned a Stoddard field strength meter that could be set in the passenger's seat. John would fly a circular route around his farm, about five miles out, with the field strength meter tuned to the transmitter frequency.

He would use a handheld two-meter walkie-talkie to ask a friend at his home station to key the transmitter that excited the test antenna. When the transmitter came up, he would mark his location and the FSM reading on the map.

Crystal Oscillator Accuracy and Stability

In the past several months, I've answered several questions on crystal oscillator specifications for the readers of this and other publications. The terms that seem to be most popular are accuracy and stability. The accuracy is the measure of the difference between the design or marked frequency and the actual frequency. Accuracy is measured in parts per million (PPM) or percent. A Citizen's Band transmitter is supposed to be within 0.005 percent of the design frequency, which is the same thing as 50 PPM. At 27 MHz, that works out to ±1,350 Hertz.

The stability of the oscillator will profoundly affect the accuracy over time. With respect to accuracy and stability, there are three basic categories of crystal oscillator: room temperature crystal oscillators (RTXO), temperature-compensated crystal oscillators (TCXO), and oven-controlled crystal oscillators (OCXO).

Room Temperature Crystal Oscillators. The RTXO takes no special precautions about frequency drift. But with proper selection of crystal cut, and reasonable attention to construction, stability on the order of 2.5 parts per million (PPM), 2.5×10^{-6}, over the temperature range 0°C to 50°C is possible. The RTXO is only used for non-critical applications (such as economy model frequency counters).

Temperature-Compensated Crystal Oscillators. The TCXO circuit also works over the 0°C to 50°C temperature range, but is designed for much better stability. The temperature coefficients of certain components of the TCXO are designed to counter the drift of the crystal, so the overall stability is improved to 0.5 PPM (5×10^{-7}). The cost of TCXOs has decreased markedly over the years to the point where relatively low-cost upgrades to economy counters gives them a rather respectable stability specification.

Oven-Controlled Crystal Oscillators. The best stability is achieved from the OCXO time base. These oscillators place the resonating crystal inside of a heated oven that keeps its operating temperature constant, usually near 70°C or 80°C.

There are two forms of crystal ovens used in OCXO designs: On/Off and proportional control. The on/off type is similar to the simple furnace control in houses. It has a snap action that turns the oven heater on when the internal chamber temperature drops below a certain point, and off when it rises to a certain maximum point. The proportional control type operates the heating circuit continuously, and supplies an amount of heating that is proportional to the actual temperature difference between the chamber and the set point. The on/off form of the oven is capable of 0.1 ppm (10^{-7}).

Table 1		
RTXO	2×10^{-9} rms	0.002 ppm
TCXO	1×10^{-9} rms	0.001 ppm
OCXO (on/off)	5×10^{-10} rms	0.0005 ppm
OCXO (prop.)	1×10^{-11} rms	0.00001 ppm

OCXOs that use a proportional control oven can reach a stability of 0.0002 PPM (2×10^{-10}) with a 20-minute warm-up and 0.0001 PPM (1.4×10^{-10}) after 24 hours. It is common practice to design the counter to leave the OCTX turned on even when the counter is off. Some portable frequency counters, such as those used in two-way radio servicing, have a battery back-up to keep the OCXO turned on while the counter is in transit.

The variation described above is referred to as the temperature stability of the counter time base. We must also consider short-term stability and long-term stability (aging).

Short Term Stability

The short term stability is the random frequency and phase variation due to noise that occurs in any oscillator circuit. It is sometimes also called either time domain stability or fractional frequency deviation. In practice, the short term stability has to be a type of RMS value averaged over one second. The short term stability measure is given as $\sigma(\Delta f/f)(t)$. Typical values of short term stability are given in Table 1 for the different forms of clock oscillator.

Long Term Stability

The long term stability of the time base clock oscillator is due largely to crystal aging. The nature of the crystal, the quality of the crystal, and the plane from which the particular resonator was cut from the original quartz crystal are determining factors in defining aging. This figure is usually given in terms of frequency units per month.

Table 2		
RTXO	3×10^{-7}/month	0.3 ppm
TXCO	1×10^{-7}/month	0.1 ppm
OCXO (on/off)	1×10^{-7}/month	0.1 ppm
OCXO (prop.)	1.5×10^{-8}/month	0.015 ppm
OXCO (prop.)	5×10^{-10}/day	0.0005 ppm

Example

The long-term stability of a digital frequency counter used to measure the output of a 467.125 MHz transmitter is specified as 0.0015 ppm/mo. What is the error seven months after the last calibration?

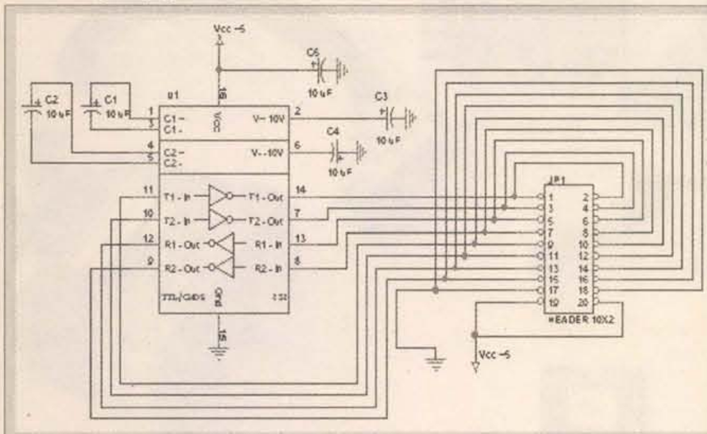
$$\pm 0.0015 \text{ ppm/mo.} \times 7 \text{ mos.} \times 467.125 = \pm 4.91 \text{ Hz}$$

NV

Connections ...

I can be reached at P.O. Box 1099, Falls Church, VA 22041, or via E-Mail at CARRJJ@AOL.COM.

Continued from page 66



ANSWER TO #10983 - OCT. 1998

DEC terminals are a little non-standard, but quite usable for the task at hand. My experience has been with the VT100-320, but I'll wager they're quite compatible.

The D-Type connector is probably a DEC standard DE-9. It will probably be easiest to just solder in the right angle connector (Jameco, lists three different depths measured from the base of the connecting portion to the first row of pins, the depths are .318", .450", .590"; they are 8 to 59 cents each.)

Unlike IBM, DEC kept the critical pins 2, 3, and 7 at those same pin numbers when converting from 25-pin to 9-pin adapters.

To convert it to a DTE, the following pinouts are used:

DEC 9-PIN > 25-PIN ADAPTER

9-PIN SIDE	25-PIN SIDE
2	3
3	2
4	5
5	6
7	7
6	20

The DEC-type connector you inquired about is an RS-422 port. It is just a standard six-pin modular jack with its tab offset so you can't accidentally plug in a phone line.

The crimp-on plugs for this were hard-to-find and expensive in it's hey-day, I doubt it would be worth the effort. But if the soldering is intimidating, you can produce one of these connectors by shaving the tab off a standard six-pin mod plug.

The outputs from the plug are differential. So you will have to tie T- and R- together to make a Signal Ground, and use T+ and R+ as Tx and Rx. A small, well-stretched piece of electrical tape applied around the body of this plug should "fatten it up" enough to stay securely in the hole.

Once you have the terminal typing back and forth with your computer (through a null-modem cable if you used the DE-9 converter). The rest is a snap.

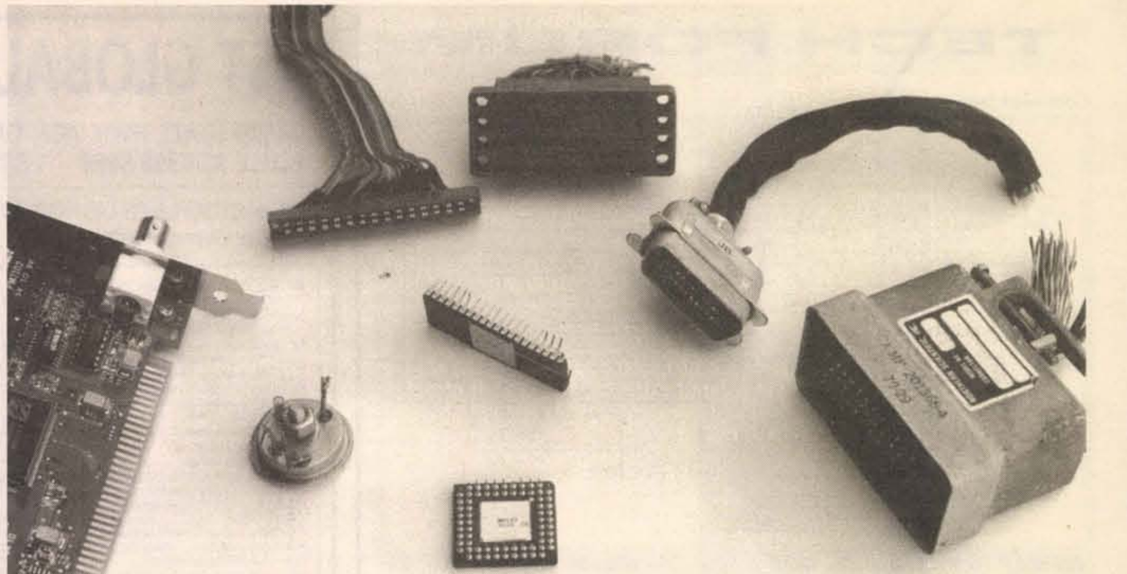
All you need is a serial line level converter like the famous MAX232. This converts the 0-5 volt signals from your 8051 to ±10, for the terminal.

Below is a circuit based on the reference design. It sets up the chip correctly and pulls the signal and power pins out to a 20-pin header. If you mount the header on the bottom side of the board you can just plug this into your breadboard whenever needed.

Jameco Part #s

DE9P318	Male 9-pin connector .318 set back
DE9P590	Male 9-pin connector .590 set back
DE9P450	Male 9-pin connector .450 set back (not listed, but may exist)
79273	6-pin mod plugs
24811	MAX232CPE
93577	10 uF Caps
53479	Dual row 20-pin straight male header

Art Popp
via Internet



by Michael E. Young

Recovery and Refining of Gold From Scrap Electronics

Introduction

Probably the most lucrative area in recycling today is in the recovery of precious metals. In this article, we will discuss the recovery of gold from scrap electronics and demonstrate a method you can use to recover gold on a small scale in your own backyard.

Finding gold-containing components is really not very hard. The basic rule you should remember is that if it looks like gold, it is gold. Don't become overly concerned with how much gold is contained in components you can't see. There are plenty of sources of visible gold available. This article describes just one method (there are others) to recover gold and is written on a scale intended for the hobbyist.

The procedure given in this article requires the use of some chemicals that are very dangerous and will require some care and preparation on your part. **So read the section on safety carefully and make sure you have all the safety equipment you need.** If you feel uncomfortable working with acids, it might be a good idea to enlist the aid of someone such as a local high school chemistry teacher to help you.

Safety

Acids can cause severe burns on skin, eyes, nose, and throat. Avoid inhalation, ingestion, and skin contact. Be familiar with the chemicals used in this procedure and use proper safety precautions. Obtain a copy of the *Material Safety Data Sheet* for all chemicals and make sure you read it and the container labels carefully.

Always wear safety goggles, laboratory apron, and chemical resistant gloves. Wear eye protection that will protect from splashes and impact. If any chemical gets in the eyes, wash them continuously with flowing water and seek immediate medical attention.

Have safety shower, eyewash, fire extinguisher, telephone and emergency phone numbers handy.

Do not inhale fumes from chemicals. Perform all experiments under an exhaust hood or outside.

Do not eat, drink, or smoke while handling chemicals.

If any chemical comes in contact with the skin, wash it immediately and summon medical assistance. Refer to the Material Safety Data Sheet for more information.

Read the chemical container warning label before removing a chemical from its container.

Never work alone!

Some Basic Facts About Gold

Gold is found in almost every piece of electronics manufactured today. It is used in semiconductor packages, connectors, printed circuits, telephones, relays, communications equipment, contacts, and switches to name only a few. Gold is used in electronics because of its properties. It has excellent conductivity, is resistant to corrosion and oxidation, and is very malleable. Gold can be fashioned into very small wires and thin sheets. An ounce of gold can be made into a sheet covering 250 square feet and only four-millionths of an inch thick or drawn into a wire 50 miles long.

Gold occurs in seawater in the amount of 0.1 to 2.0 milligrams (mg) per ton and the earth's crust is estimated to have an average gold content of about 0.0034 gram per metric ton.

Gold is measured in "troy" weight. There are 31.1 grams of gold in a troy ounce. Since gold is usually alloyed with other metals, a measurement called the "karat" is used to express the amount of gold with 24 karat being pure gold. For example, 14 karat gold contains 14 parts gold and 10 parts other metals. Fineness refers to the weight proportion of pure gold in an alloy expressed in parts per thousand.

Gold resists attack by most chemicals including nitric acid, sulfuric acid, and hydrochloric acid. However, it can be dissolved in aqua regia. Aqua regia is a solution of one part concentrated nitric acid and three parts concentrated hydrochloric acid. It means "royal water."

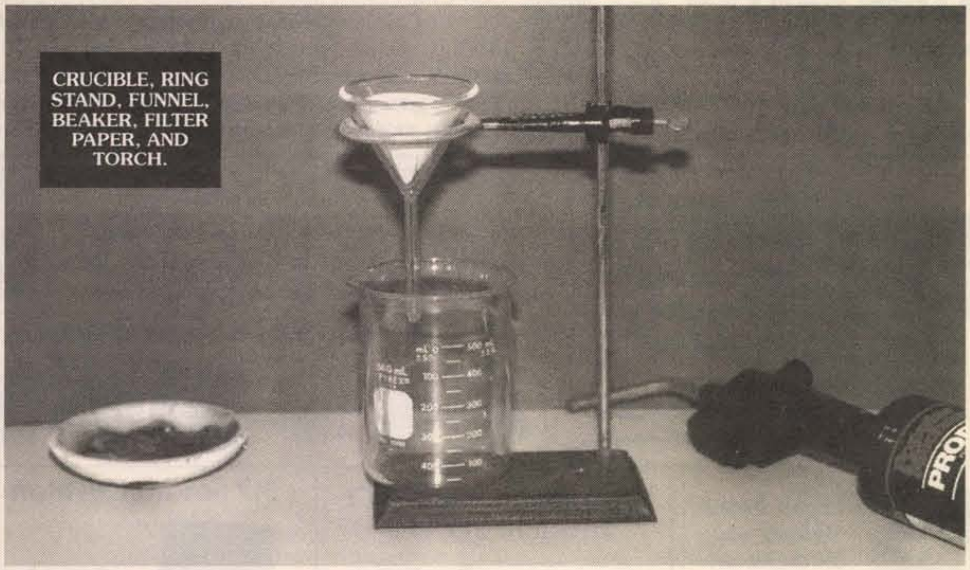
Sources of Gold

The first step is to obtain some gold containing components. This can be some old military connectors, circuit card edges, gold plated terminals, or contacts. Remember if it looks like gold then it's worth getting. Also, the older the electronics are, the thicker the gold is likely to be. This is because gold was cheaper then and the methods used to deposit gold were not as good as they are now. So older material is better, but it's not necessary.

Some moderately-sized operations

A. Hydrochloric Acid HCl (reagent)
B. Nitric Acid HNO_3 (reagent)
C. Dibutyl Carbitol (diethylene glycol dibutyl ether)
D. Potassium Oxalate $K_2C_2O_4$
E. Distilled Water
F. Filter Paper
G. One 500ml Beaker and One 600ml Beaker
H. Glass Funnel
I. Stainless Steel Forceps or Long Tweezers
J. Crucible
K. Propane Torch
L. Ring Stand

Table I: Supplies and Equipment



CRUCIBLE, RING STAND, FUNNEL, BEAKER, FILTER PAPER, AND TORCH.

have grinders to grind up entire circuit boards and then process the grindings. Gold-plated components are recommended here to make it easy to see that the process is working.

Physically strip down the electronics and remove only the components that contain gold. In a connector, this means removing the gold-plated contacts; on a circuit card this means cutting off the edge connector. Reduce the components down to just the parts that have gold on them. For the purposes of this article, each piece should all be small enough to fit in a small laboratory beaker. To complete the process described below, you will need about enough gold-plated parts to fill a quart jar.

Required Materials

Table I is a list of the chemicals and chemical supplies you will need. Note that this list does not include the safety equipment you need that was mentioned earlier. Some sources to obtain these supplies are listed in Table II. A local chemical supply company, as well as the chemical supply store at a nearby university, are good places to start. Also, the acids must be laboratory grade. Diluted acids will probably give poor results or not work at all.

Procedure

Once you have all the supplies, chemicals, and some gold-bearing components ready, you can begin. It is important that you read the whole procedure as it is written here before you begin. Make sure you understand everything and that you have everything you need. Also make sure you are familiar with the section on safety. The following is the step-by-step procedure to remove the gold from the components that you collected earlier.

Prepare a solution by mixing 50ml of nitric acid with 150ml of hydrochloric acid in a 500ml beaker. This liquid is yellow and produces poisonous, suffocating fumes. The solution of one part nitric acid and three parts hydrochloric acid is called aqua regia.

Use the stainless steel forceps to place some of the gold-bearing components in the solution. The gold will immediately begin to be stripped and dissolved. Observe the components carefully and remove them as soon as it appears that all the gold has been removed. Discard these and place some fresh components in the solution. Repeat this step until you run out of components or the aqua regia grows weak. You will know this because the reaction will slow and it will take longer to see the gold disappear.

Add about 100ml of distilled water to the solution from step 2 and stir gently. To this, add about 30ml of dibutyl carbitol and continue to stir gently. You should notice a brown extract forming in the beaker that will settle to the bottom. Allow the solution to sit until the brown extract settles to the bottom of the beaker. Carefully pour off the liquid into another beaker being careful to leave the extract behind in the first beaker.

To the beaker containing the brown extract, add distilled water in volume of about the same as the extract. Add about 2-3 grams of potassium oxalate and stir. It is desirable to stir this solution for a few hours, but good results can be had with less.

Remove the extract from the solution by pouring it into a glass funnel lined with filter paper. Make sure the solution is diluted with distilled water enough so that the acid does not melt the filter paper. Rinse with water until all of the extract is washed into the filter paper.

Place the filter paper in the crucible and allow to dry. Then take a propane or oxygen/propane torch and gently heat the filter paper and extract. The filter paper will burn away. Continue to slowly heat the brown powder until it begins to vaporize. As the powder vaporizes you will see a small pellet of gold begin to form in the bottom of the crucible. Be careful not to over heat the gold causing it to boil away. Take care that the force of the torch flame doesn't blow the extract or the gold out of the crucible. Keep the torch on the lowest flame necessary.

Summary

It is not unusual to obtain one or two grams of relatively pure gold on this scale. The gold obtained is typically of good purity with low concentrations of alloyed metals such as copper. Of course, more gold can be obtained per run by increasing the scale of this process.

Any number of variables can affect the outcome. One of these factors is temperature. You might want to experiment with warming the solution during the final stirring (step 4). Of course, the quality of the chemicals and the quality of the gold components will make a difference. While this particular process is useful for the hobbyist, there are several other processes that may be more appropriate for larger scale operations. These mainly vary in the method used to extract the gold from the aqua regia solution. This is a good area to experiment in and to do research.

Although the emphasis of this article is the recovery of gold from scrap electronics, the procedure for recovering gold from other sources such as jewelry, dental work, trophies, or eyeglass frames is essentially the same. Any gold-plated components can be used. **NV**

Michael Young can be contacted at myoung@mail.ala.net or P.O. Box 145, Newville, AL 36353.

31.1 grams (g) = 1 troy ounce
10^3 grams (g) = 1 kilogram (kg)
453.59 grams (g) = 1 pound (lb)
1 milliliter (ml) = 1 cubic centimeter (cm^3)
1 milliliter (ml) = 10^{-3} liters (l)
Melting point of gold 1064.4° C or 1947° F
Boiling point of gold 2857° C or 5174.6° F

Table III: Units, Conversions, and Properties

Fluka Chemical
980 South 2nd Street
Ronkonkoma, NY 11779
1-800-358-5287

Fisher Scientific
711 Forbes Avenue
Pittsburgh, PA 15219-4785
1-800-766-7000

Thomas Scientific
P.O. Box 99
Swedesboro, NJ 08085-0099
1-800-345-2100

Hagenow Laboratories Inc.
1302 Washington Street
Manitowoc, WI 54220

Sigma Chemical Company
P.O. Box 14508
St. Louis, MO 63178
1-800-325-3010

Aldrich Chemical Company
940 West Saint Paul Avenue
Milwaukee, WI 53233
1-800-558-9160

Table II: Sources of Supplies

Write in 218 on Reader Service Card.

AMATEUR ROBOTICS NOTEBOOK

by Robert Nansel

Last time, I showed how to build a SIMMStick compatible with the Parallax BS-2. In the coming year, I intend to describe more projects using PBASIC controllers (such as the BS1-IC and the BS2-IC), but for the next few months, I want to shift into a different SIMMStick groove, one that will give at least a big price/performance boost over Stamps and offer much more flexibility.

There's a price to be paid for all these benefits, of course, and that price is learning to program in machine language – PIC assembly language in particular. The learning curve can be steep, but once you've done it, the results will more than justify the effort required.

In the process, I'll be showing you lots of tools, techniques, and resources that will ease the transition from PBASIC Stamps to assembly language Screamers. This month, I've also got tidbits on a better way to bend wire and where to look for technological inspiration.

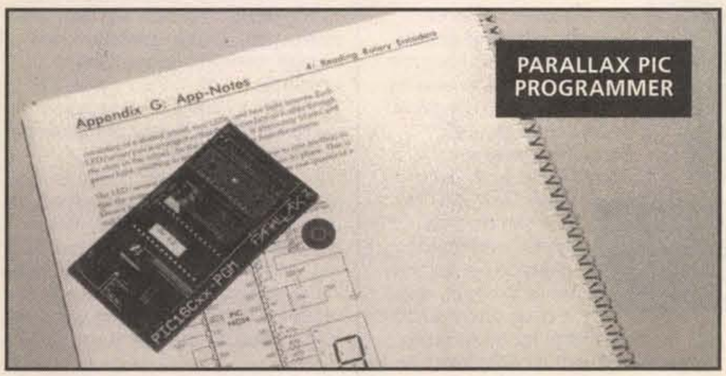
PICs, Stamps, and Ants

So far, all of the Breadbot projects I've presented in this column have used controllers programmed in either PBASIC I or PBASIC II. This has been convenient from the standpoint of just getting something up and running with a minimum of time, hassle, and cash. If you build more than one Breadbot, though, the cost of the PBASIC controllers, whether from Parallax or homebrewed with a SIMMStick, will mount up.

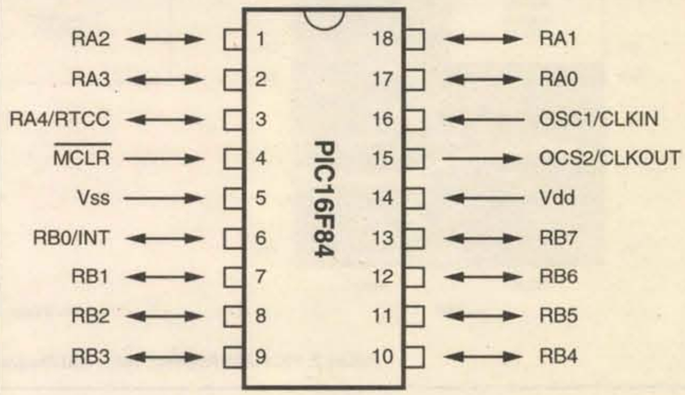
The BS2 SIMMStick from last time costs under $40.00 US, not much cheaper than the Parallax BS2-IC ($49.00 US). I could shave three, maybe four dollars off by soldering the chips in instead of using IC sockets, by using a ceramic resonator instead of a crystal, and by leaving out the voltage regulator (which isn't being used in Breadbot at present). If I were building just a couple Breadbots, I might well go this route if I wanted to stay with PBASIC as my programming environment.

But what if I want to build a dozen Breadbots, say for a robot ant colony? The cost of a dozen BS-2 SIMMStick brains alone would be about $430.00 US, and it's likely that all the extra sensors and interant communications needed would make the BS2 choke. At this point, I have to ask myself if there is a better way.

The most expensive part of the BS2 SIMMStick is Parallax's PBASIC II chip, which is really just a PIC16C57



PARALLAX PIC PROGRAMMER



Pin	Function
Vdd	Power supply 4.0 - 6.0 volts
Vss	Ground
RA0 - RA4	I/O Port A
RB0 - RB7	I/O Port B
INT	External interrupt input
RTCC	Real-time clock/counter input
MCLR	Master clear (reset)
OSC1/CLKIN	Oscillator input
OSC2/CLKOUT	Oscillator output (OSC/4)

Figure 1: PIC16F84 pin-out

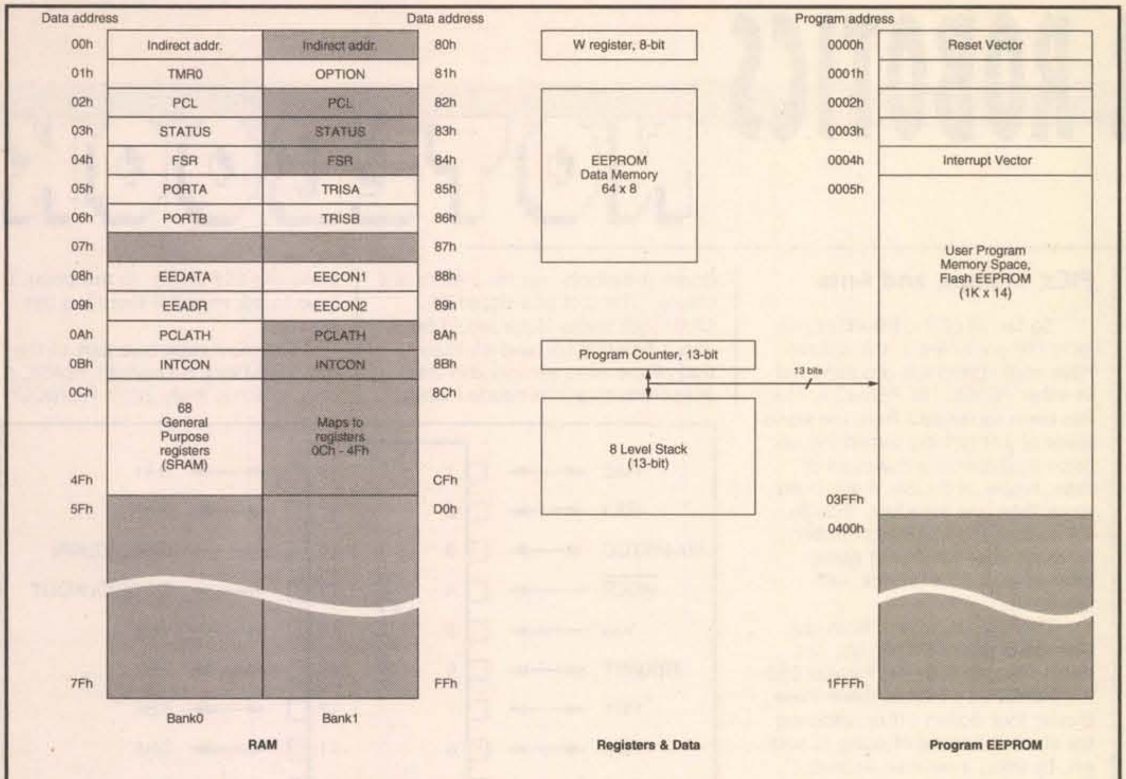
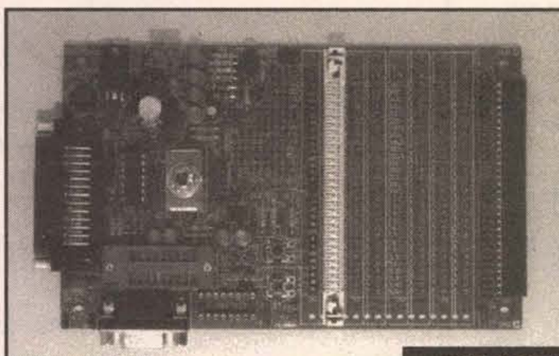


Figure 2: PIC16F84 Register, Data, and Program memories

programmed with Parallax's proprietary firmware.

The PIC16C57 currently cost less than $6.00 US in a quantity of one for the "OTP" version, less than a quarter the price of the PBASIC II chip; if I could use a plain vanilla PIC, the cost of each Breadbot controller would be cut in half.

The problem with this rosy picture, though, is "OTP." That stands for one-time-programmable; great for production, but not for experimentation. There is a UV-erasable EPROM version of the PIC16C57, but it costs $11.00 US. This is still cheaper than the PBASIC II, but I don't want to deal with the hassle of UV erasure. In-circuit reprogrammability is one of the big advantages of the BASIC Stamps, and I'm loathe to let it go.



DONTRONICS DT001 SIMMStick DEVELOPMENT SYSTEM

Luckily, Microchip has an EEPROM PIC available, the PIC16F84.

Flash to the Rescue

The PIC16F84 is a member of Microchip's family of 14-bit core microcontrollers (the PIC16C57 is part of their older 12-bit family). It comes in a plastic package with 18 pins, of which 13 are I/O lines. It has 68 eight-bit words of directly addressed general-purpose R/W data memory and 64 eight-bit words of indirectly addressed data EEPROM. The program is stored in 1K by 14-bit Flash EEPROM. The F84 can thus be erased and reprogrammed in seconds while in-circuit, and it costs under $7.00 US, making it ideal for robot prototype development (see Figures 1 and 2).

The 14-bit core PICs can't all compete with a Motorola 68HC11 in terms of on-chip RAM and EPROM, and they have no expansion bus so you can't add more RAM or ROM externally. They excel, though, where you need something small and fast, just enough computing horsepower to do the job. And cheap.

Even a low-end chip like the 68HC11A1 costs twice as much as a PIC16F84 and, unlike the Motorola chip, when you are satisfied with your code on an F84, you can easily port it to another 14-bit core PIC, such as the PIC16C711. The PIC16C711 comes in a pin-compatible OTP package functionally identical to the F84, only it has four optional A/D inputs, and it's two times faster and costs a couple dollars less than the F84.

For simple applications, you could even go all the way down to one of the eight-pin PICs now available, such as the PIC12C671 and PIC12C672, both under $4.00 US. Motorola has nothing even close to these.

Still, some of you may be more familiar and comfortable with the HC11's instruction set and architecture, and the first time you look the PIC over it may seem alien and primitive. Some years ago when I first read the PIC databooks, I had that same impression, but they have grown on me. Let me tell you why.

Tour de PIC

Since the PIC doesn't have all the fancy built-in addressing modes of the 68HC11 (which has over 300 instructions), some operations will require more PIC instructions to accomplish — but, then again, the PIC16F84 has only 35 instructions to begin with, so it's easy to memorize them all (see Table 1).

The F84 has most of the binary arithmetic instructions you expect in an eight-bit microcontroller, including adding, subtracting, incrementing, decrementing, and bit-wise logical operations. It doesn't have BCD math instructions, so those will have to be faked in software if you need them.

Of special interest to control freaks (that's you, the Amateur Robot Builder, bubba), the PIC has a

R/W-0	R/W-0	R/W-0	R-1	R-1	R/W-x	R/W-x	R/W-x
IRP	RP1	RP0	$\overline{TO}$	$\overline{PD}$	Z	DC	C
bit 7							bit 0

R = Readable bit   W= Writable bit   - n = Value at Power On Reset (POR)

Bit 0: **C:** Carry/$\overline{\text{Borrow}}$ bit
1 = Carry from msb of result occurred
0 = No carry from msb of result occurred
For subtraction, **C** behaves like a Positive flag that is set when the result is not less than zero, and cleared when the result is negative. For rotate instructions, **C** is loaded with either the high order bit (for `RLF`) or the low order bit (for `RRF`) of the source register.

Bit 1: **DC:** Digit Carry/Borrow bit
1 = Carry from bit 3 of result occurred
0 = No carry from bit 3 of result occurred
DC indicates when more than one 4-bit hex digit was necessary to accomodate the result. For subtract operations **DC** behaves in the same manner as **C**, except it operates only on the least significant nybble.

Bit 2: **Z:** Zero bit
1 = The result of an arithmetic or logic operation is zero
0 = The result of an arithmetic or logic operation is not zero

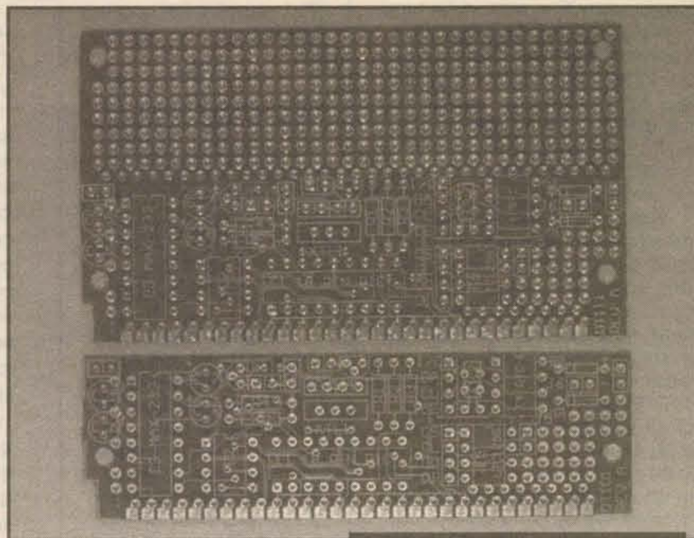
Bit 3: **$\overline{PD}$:** Power-down bit
1 = After power-up or `CLRWDT` instruction
0 = After `SLEEP` instruction

Bit 4: **$\overline{TO}$:** Time-out bit
1 = After power-up, `CLRWDT` instruction, or `SLEEP` instruction
0 = A Watch Dog Timer time-out occurred

Bit 5-6: **RP0, RP1:** Register Bank Select bits for direct addressing
00 = Bank 0: 00h - 7Fh
01 = Bank 1: 80h - FFh
10 = Bank 2: 100h - 17Fh (unimplemented on PIC16F84)
11 = Bank 3: 180h - 1FFh (unimplemented on PIC16F84)
Each bank is 128 bytes. Only **RP0** is used by PIC16F84; **RP1** should remain clear.

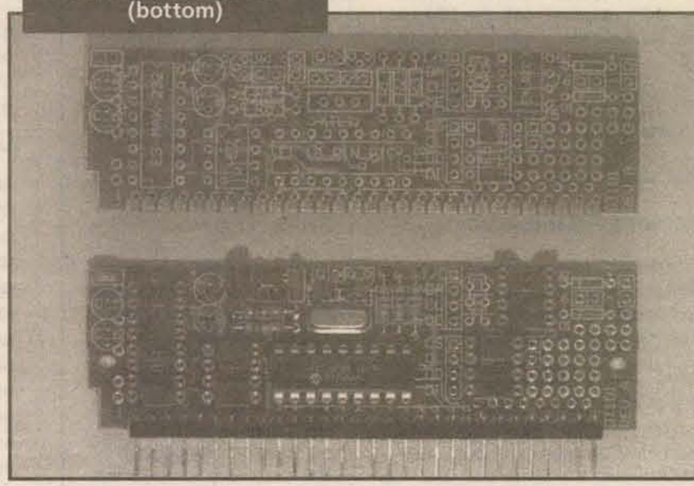
Bit 7: **IRP:** Register Bank Select bit for indirect addressing
0 = Bank 0, 1: 00h - FFh
1 = Bank 2, 3: 100h - 1FFh
IRP bit is not used by PIC16F84, and should remain clear.

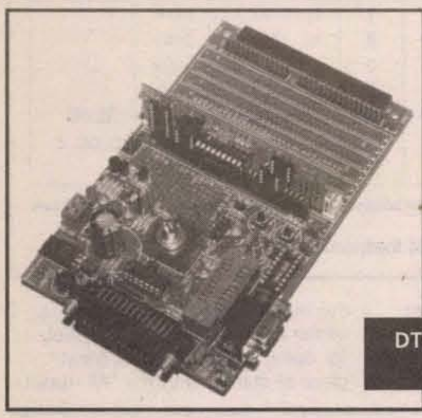
Figure 3: File Status Register (FSR) Flags



DONTRONICS DT101 & DT111 SIMMSticks

BARE DT101 (top) AND POPULATED BOARD (bottom)





DT001 WITH DT101 BOARD IN PROGRAMMING SLOT

couple instructions — BSF and BCF — which allow direct setting or clearing of any individual writable bit in RAM without the need for sequences of ANDing or ORing an entire byte with a bit mask to isolate the one bit you are after. BSF and BCF are paired up with BTFSS and BTFSC, the bit test and skip instructions (more on these in a moment).

The PIC's branching instructions take a little getting used to. While the PIC does have ordinary unconditional GOTO, CALL, and RETURN-type instructions, it has no true conditional branching instructions. Instead, it has conditional *skipping* instructions, that is, instructions that skip over the instruction immediately following them when their conditional is satisfied. DECFSZ, for instance, skips the next instruction if, after decrementing a file register, the result is zero. INCFSZ works the same way, except the file register is incremented. Two other skip instructions, BTFSC (bit test f, skip if clear) and BTFSS (bit test f, skip if set) do similar jobs, but their conditionals can be any bit in RAM, including bits in the STATUS register.

But to get true conditional branches, it does take two PIC instructions. Place an unconditional GOTO after any of the four skip-type instructions, and when the skip condition is true, the GOTO instruction is skipped and execution resumes with the instruction following the GOTO. Likewise, combining a skip with CALL or RETURN gives you conditional subroutine calls and returns.

Having to use two instructions to perform what most other processors do with one may seem to be a drag, but you get much more flexibility overall. Because they require two instructions to implement, conditional branches take up two program words, or 28 bits.

The nearest equivalent single-instruction branch in a 68HC11 would take up just 16 bits, or two bytes, one byte for the branch opcode and one byte for the relative branch address. But note that eight-bit relative branches only allow branches in the range from -128 to +127. For an HC11 conditional branch to access its entire memory range, as the PIC's skip/goto combination can, you need to combine a branch with the unconditional jump, a total of five bytes, or 40 bits. The PIC comes out the clear winner. For the same functionality, the PIC model takes up less chip real estate.

To complete this short tour of the PIC instruction set, the F84 has two housekeeping instructions, CLRWDT which is the only instruction that can clear the Watch Dog Timer, and SLEEP, which puts the F84 into a lower-power standby mode.

That's it. Thirty-five instructions. That wasn't so bad, was it?

Harvard Architecture

The PIC family of microcontrollers are all examples of Harvard Architecture computers. This means they have separate program and data memory busses instead of the single memory bus used in traditional Von Neumann architecture machines. In Von Neumann machines, program and data are fetched over the same bus, and this makes the shared bus a bottleneck.

Having separate busses not only eliminates the bottleneck, it greatly simplifies the circuitry of the MPU and increases memory efficiency since the sizes of instruction and data words need not be the same. It also allows the MPU to simultaneously access both program instructions and data. This, combined with efficient pipelining explains why PICs are so fast.

A PIC16F84 operating with a 10-MHz crystal has a 400 ns instruction cycle time, and all instructions execute in a single cycle, except instructions which change the program execution flow (i.e., branches, subroutine calls, and returns; these take two cycles).

Interrupt latency — the time it takes the PIC to respond to an interrupt — is very short, just three to four processor cycles, independent of the instruction being interrupted. For a 10-MHz system, this corresponds to a delay of 1.2 to 1.6 microseconds before interrupt processing begins. In contrast, a Motorola 68HC11 running at 8 MHz can take anywhere from two to 41 processor cycles — one to 20.5 microseconds — to begin processing an interrupt, which can introduce unacceptable jitter in some systems.

Another wrinkle of the PIC's Harvard architecture is that separate program and data memory spaces make it impossible for a PIC program to erroneously execute data. Neither can instructions in the program space accidentally be corrupted by data overwrites. This increases the resistance of the controller to electrical upsets common in control systems and makes for a more reliable system.

PIC Development Tools

Okay, assuming you're now at least interested in using PICs in robots, how do you program them? A quick search on the Web will get you hundreds of links, and you could spend months following all the interesting ones. To save you some time, I've included a sidebar with my list of the best of what's on the Web for doing things PICish. A great place to start is with the "All About

Mnemonic,	Operands	Description	Cycles	14-bit Opcode MSB LSB	Flags Affected
BYTE-ORIENTED FILE REGISTER OPERATIONS					
ADDWF	f,d	Add W and f	1	00 0111 dfff ffff	C, DC, Z
ANDWF	f,d	AND W with f	1	00 0101 dfff ffff	Z
CLRF	f	Clear f	1	00 0001 1fff ffff	Z
CLRW	—	Clear W	1	00 0001 0000 0011	Z
COMF	f,d	Complement f	1	00 1001 dfff ffff	Z
DECF	f,d	Decrement f	1	00 0011 dfff ffff	Z
DECFSZ	f,d	Decrement f, Skip if 0	1(2)	00 1011 dfff ffff	
INCF	f,d	Increment f	1	00 1010 dfff ffff	Z
INCFSZ	f,d	Increment f, Skip if 0	1(2)	00 1111 dfff ffff	
IORWF	f,d	Inclusive OR W with f	1	00 0100 dfff ffff	Z
MOVF	f,d	Move f	1	00 1000 dfff ffff	Z
MOVWF	f	Move W to f	1	00 0000 1fff ffff	
NOP	—	No Operation	1	00 0000 0xx0 0000	
RLF	f,d	Rotate f Left through Carry	1	00 1101 dfff ffff	C
RRF	f,d	Rotate f Right through Carry	1	00 1100 dfff ffff	C
SUBWF	f,d	Subtract W from f	1	00 0010 dfff ffff	C, DC, Z
SWAPF	f,d	Swap nybbles in f	1	00 1110 dfff ffff	
XORWF	f,d	Exclusive OR W with f	1	00 0110 dfff ffff	Z
BIT-ORIENTED FILE REGISTER OPERATIONS					
BCF	f,b	Bit Clear f	1	01 00bb bfff ffff	
BSF	f,b	Bit Set f	1	01 01bb bfff ffff	
BTFSC	f,b	Bit Test f, Skip if Clear	1(2)	01 10bb bfff ffff	
BTFSS	f,b	Bit Test f, Skip if Set	1(2)	01 11bb bfff ffff	
LITERAL AND CONTROL OPERATIONS					
ADDLW	k	Add literal to W	1	11 111x kkkk kkkk	C, DC, Z
ANDLW	k	AND literal with W	1	11 1001 kkkk kkkk	Z
CALL	k	Call subroutine	2	10 0kkk kkkk kkkk	
CLRWDT	—	Clear Watchdog Timer	1	00 0000 0110 0100	$\overline{TO}$, $\overline{PD}$
GOTO	k	Go to address	2	10 1kkk kkkk kkkk	
IORLW	k	Inclusive OR literal with W	1	11 1000 kkkk kkkk	Z
MOVLW	k	Move literal to W	1	11 00xx kkkk kkkk	
RETFIE	—	Return From Interrupt	2	00 0000 0000 1001	
RETLW	k	Return with literal in W	2	11 01xx kkkk kkkk	
RETURN	—	Return from Subroutine	2	00 0000 0000 1000	
SLEEP	—	Go into standby mode	1	00 0000 0110 0011	$\overline{TO}$, $\overline{PD}$
SUBLW	k	Subtract W from literal	1	11 110x kkkk kkkk	C, DC, Z
XORLW	k	Exclusive OR literal with W	1	11 1010 kkkk kkkk	Z

f = file address   d = dest: 0 for W, 1 for f   b = bit address   k = literal constant   x = don't care

Table 1: PIC16F84 Instruction Set

PIC" website. If this site doesn't point you to what you need, I don't know what will.

You'll be astonished at the sheer mass of PIC development software and hardware tools out there, from the expensive commercial development tool suites to the anarchic, homebrew, by-gosh-it-actually-works gear. Most of the latter is freeware or shareware, much of it surprisingly good.

First, you'll need an assembler of some kind. For Wintel users, one place to start is with the Mothership itself: the Microchip website. They have available for download a good macro assembler – MPASM – and a serviceable simulator – MPSIM. They also will gladly point you to higher-end tools such as emulators and optimizing C compilers.

For Macintosh users, there are several excellent software packages available. I've been using the Crossbow cross-assembler package for many years, long enough ago that I actually paid for it. I would kick myself now that it's available as freeware from Peripheral Issues, but it's an even better product covering more processors now than when it was commercial. It's an integrated editor, macro assembler, and downloader, and it assembles code for every common eight-bit processor out there (and a few uncommon ones, too).

I've also used MacPIC by Kevin Coble. It's shareware with a integrated editor, assembler, simulator/debugger, and downloader. Topnotch.

Next, you'll need some hardware to actually program the PICs. The sheer number of choices here will surely boggle your mind. Most programmers require a PC with a parallel port to operate, though a few use a serial interface (which Mac and Linux users will appreciate). No matter what your budget or performance needs, I guarantee you'll be able to find a programmer that will suit you.

Despite being a devoted Mac user, I don't yet own a serial port PIC programmer. I do, however, own and use two different parallel port programmers, the DonTronics DT001 and the Parallax PIC16Cxx-PGM (see photos). I use these with my toy computer, an embarrassing 386 DOS machine I keep in my basement so folks won't see it.

The DT001 can be configured to program individual chips, to program SIMMStick boards in-circuit, or to function as a SIMMStick motherboard, complete with expansion connectors and RS-232 communications. It's available as a bare PC board directly from DonTronics in Australia or from any of the numerous SIMMStick distributors world-wide. I've purchased boards and parts from both Don at DonTronics and Ben Wirz at Wirz Electronics; they're good people, with fast and courteous service. The DT001 is well-documented and inexpensive to build. Recommended.

The Parallax PIC16Cxx-PGM costs a bit more than the DT001, but it comes already built and can handle a wider range of PIC chips, including the older 12-bit core family, which use a different programming method than Microchip's newer PICs. It's available in a "Hobbyist Pack" for $109.00 US from Digi-Key (www.digikey.com).

With the Hobbyist Pack, you'll have to supply your own wall-wart power transformer, build the interface cable, and print out the documentation yourself. This will cost you about $10.00 and half an hour of your time, but when you are finished you'll have saved yourself over $100.00.

Once you have an assembler, a programmer, and the software to run it, then you need a way to build the PIC into a circuit. There are scads of PIC breadboards out there. I have two favorites: the line of PICProto boards from microEngineering Labs and, of course, SIMMSticks.

More Options, More Options!

Among his many SIMMStick products, Don McKenzie of DonTronics fame has two great boards available – the DT101 and the newer DT111 – designed especially for 18-pin PICs such as the 16F84. The only difference between the two is the DT111 is a double-height SIMMStick with a nice proto-

PIC and SIMMStick Internet Resources:

Advanced Transdata Corp.
14330 Midway Rd.
Suite 128
Dallas, TX 75244
Tel: 972-980-2960
Fax: 972-980-2937
www.adv-transdata.com
(RICE17A in-circuit emulator, PGM16N and PGM2000 programmers)

"All About PIC" website
www.ormix.riga.lv/eng/mchip/mchip.htm
(Incredible number of links to PIC resources)

Byte Craft Ltd.
421 King Street
North Waterloo
Ontario, Canada N2K 4E4
Tel: 519-888-6911
Fax: 519-746-6751
www.bytecraft.com

CCS
P.O. Box 2542
Brookfield, WI 53008
Tel: 414-781-2794 x30
Fax: 414-781-3241
www.ccsinfo.com/picc.html
(PIC C compilers for DOS and Windows)

COMFILE Technology
Seoul, Korea
Tel: 82-2-711-2592
Fax: 82-2-711-2593
www.comfile.co.kr
(PIC12/14/16 Emulator/programmer)

Dallas Semiconductor
4401 South Beltwood Parkway
Dallas, TX 75244-3292
Tel: 972-371-4448
Fax: 972-371-3715
www.dalsemi.com
(Serial RTCs, temp. sensors, batt. monitors)

DonTronics
P.O. Box 595
Tullamarine 3043
Australia
Tel: +61 3 9338-6286
Fax: +61 3 9338-2935
dontronics.com
(SIMMStick PC boards, development systems, and software)

HI-TECH Software LLC
7830 Ellis Road
Suite 105
Melbourne, FL 39204
Tel: 1-800-735-5715
Fax: 407-722-2902
(HI-TECH PIC C compiler for the PIC16Cxx)

HI-TECH Software
P.O. Box 103
Alderley, QLD 4051
AUSTRALIA
Tel: +61 7 3354 2411
Fax: +61 7 3354 2422
(HI-TECH PIC C compiler for the PIC16Cxx)

ITU Technologies
3704 Cheviot Ave. Suite 3
Cincinnati, OH 45211
Tel: 1-888-448-8832, 513-661-7523
Fax: 513-661-7534
www.itutech.com
(PIC development systems, programmers, compilers)

Linear Technology Corporation
1630 McCarthy Blvd.
Milpitas, CA 95035-7417
Tel: 1-800-454-6327, 408-432-1900
Fax: 408-434-0507
www.linear-tech.com
(Serial A/D & D/A convertors)

Linux RS-232 PIC programmer
by Jaakko Hyvatti
www.iki.fi/hyvatti/pic/picprog.html

MacPIC, by Kevin Coble
ftp://ftp.srv.net/pub/users/kxc/
(Macintosh shareware: integrated editor, assembler, simulator/debugger, and programmer for PIC microcontroller)

Microchip Technology, Inc.
Tel: 1-888-628-6247, 602-786-7200
Fax: 602-899-9210
www.microchip.com
(PIC chips, PICSTART development systems, MPASM assembler, MPSIM simulator, serial EEPROMs)

microEngineering Labs, Inc.
Box 7532
Colorado Springs, CO 80933
Tel: 719-520-5323
Fax: 719-520-1867
www.melabs.com
(PIC prototyping boards, EPIC programmer, PicBasic Pro Compiler)

Micro Mint
4 Park St.
Vernon, CT 06066
Tel: 1-800-635-3355, 860-871-6170
Fax: 860-872-2204
www.micromint.com
(PicStics & BASIC compiler)

Myke Predko
www.myke.com
(author of *Programming and Customizing the PIC Microcontroller*)

National Semiconductor Corp.
2900 Semiconductor Drive
Santa Clara, CA 95052-8090
Tel: 1-800-272-9959
TWX: 910-339-9240
www.national.com
(Serial A/D & D/A convertors)

Parallax, Inc.
3805 Atherton Road, Ste. 102
Rocklin, CA 95765
Tel: 1-800-512-1024, 916-624-8333
www.parallaxinc.com
(PIC16Cxx-PGM programmer, SX-Key debugger/programmer, BASIC Stamps)

Peripheral Issues
P.O. Box 543
Mashpee, MA 02649
Tel: 508-563-7190
Fax: 508-563-7191
www.periph.com/crossboweb/Crossbow.html
(Freeware Crossbow cross assembler for the Macintosh)

RS-232 Serial PIC programmer project, by Jens Madsen
www.gbar.dtu.dk/~c888600/newpic.htm

Scenix Semiconductor
3160 De La Cruz Blvd. Suite 200
Santa Clara, CA 95054
Tel: 408-327-8888
Fax: 408-327-8880
www.scenix.com
(SX18/20AC100 MCU chips, backward-compatible with PIC 16C5x)

Scott Edwards Electronics, Inc.
P.O. Box 160
Sierra Vista AZ 85636
Tel: 520-459-4802
Fax: 520-459-0623
www.seetron.com
(Counterfeit Stamp, SSC Serial Servo Controller, Serial LCD)

SIGNUM Systems
Thousand Oaks, CA
Tel: 1-800-838-8012
Fax: 805-371-4610
www.signum.com
(ICEPIC in-circuit emulator)

Sirius microSystems
172 Harvard Road
Waterloo
Ontario, Canada N2J 3V3
Tel: 519-886-4462
Fax: 519-886-4253
www.siriusmicro.com
(PIC development boards, programmers, assembler)

Square 1 Electronics
P.O. Box 501
Kelseyville, CA 95451
Tel: 707-279-8881
Fax: 707-279-8883
www.sq-1.com
(*"Easy PIC'n"* & *"PIC'n Up The Pace"* books)

TechTools
P.O. Box 462101
Garland, TX 75046
Tel: 972-272-9392
Fax: 972-494-5814
www.tech-tools.com
(PICmicro in-circuit emulator, assembler)

Wirz Electronics SIMMSticks
P.O Box 457
Littleton, MA 01460-0457
Tel: 1-888-289-9479
Fax: 978-448-0196
www.wirz.com
(SIMMSticks, SLI serial LCD interface, kits)

PICLIST List Server
The PICLIST is one of the most helpful resources for PICs on the Internet. To subscribe to the PICLIST, send an E-Mail to:
listserv@mitvma.mit.edu
with a blank subject line, and a body of SUB PICLIST. Be warned: there are thousands of people on this list, and it generates 200+ messages a day.

typing area added above the single-height DT101 layout. Both are high-quality boards with component placement silkscreen, solder mask, and heavy power and ground trace layout.

In the minimal configuration (see photo), these boards need only an F84 and either two 15 pF capacitors and a crystal or a three-pin ceramic resonator.

But there are many more options — "More options, more options!" seems to be Don's rallying cry — so you can choose according to your needs. There are four pre-wired options (all you have to do is solder the necessary components in place) and two more options requiring a few wire jumpers each to connect them to the rest of the circuit.

The first pre-wired option (PWO) you can add is a simple on-card voltage regulator. Don has thoughtfully provided pads on the regulator output where you can install a two-pin header; cut the trace between the pads, and then you can use a shorting jumper to isolate the output of the regulator circuit as needed.

This is necessary if you want to program the SIMMStick in-circuit on the DT001 programmer. The DT001 switches pin 7 of the SIMMStick bus (SS-Bus) between +5V and the programming voltage Vpp and, if you have an on-card regulator installed on the SIMMStick, you must temporarily isolate its output so it doesn't fight the programmer voltage.

The second PWO is to add two reset resistors and a pullup for the PIC's RTCC pin (pin 14, "IO," on the SS-Bus). You can also install a TO-92 package brown-out reset IC to put the F84 into reset when the power supply goes squirrely and voltage drops. I recommend installing the brown-out IC — robot power supplies are heinously noisy.

The third PWO is an eight-pin 24LCxx-type serial EEPROM. These I2C devices range in capacity from 1 to 64 Kbits and can be used for storing auxiliary data or tokens to be interpreted by a virtual machine programmed into the PIC.

This is the way the BS2 SIMMStick works, and Dunfield Development Systems (www.dunfield.com/catalog.html#cflea) has CFLEA, an interpreted C that can use the same token storage approach.

The fourth PWO is an RS-232 serial level translator. Just add a MAX-232 chip and four 1 uF capacitors, and you get a standard RS-232 interface. Not as funky as the two-transistor method BASIC Stamps use, but it's reliable and full-duplex.

Finally, Don has provided two partially-wired options. The first is a place to put an eight-pin SPI or Microwire-type serial interface ADC or DAC. The second is a place to put an eight-pin, serial interface real-time clock/calendar chip, along with its 32.768 KHz crystal, and steering diodes for an optional 3V coin cell for battery backup.

Squashing the Learning Curve

If my rants above and the Web resources in the sidebar aren't enough for you to get going with PICs, then you'll need to hit the books. The bible for all PIC microcontrollers is Microchip's own *PIC16/17 Microcontroller Databook*. The writing is often turgid and the order of presentation sometimes confusing, but this book is the authority of last resort. The answer is in there — if you can find it and decipher it.

Fortunately, there are third-party books around to help you scale the steep learning curve. For those new to assembly language in general and to PICs in particular, I would recommend *Easy PIC'n* and the follow-up *PIC'n up the Pace* from Square 1 Electronics. These books will take you by the hand and very gently initiate you into the mysteries of PIC programming.

If you've already learned to program a few other microcontrollers, or if you just want something more assertive and meaty than the *PIC'n* books, then you might find *Programming and Customizing the PIC Microcontroller* (McGraw-Hill 1998, ISBN 0-07-913646-X) by Myke Predko more to your taste. It's my first choice, hands down.

And, if all this PIC stuff is making your head throb and kindling a desire to break things, I have just the gadget for you.

Mini Wire Bender

In my very first "Amateur Robotics Notebook" column (June '98), I described how to improvise a wir,e-bending jig from a hunk of wood and a couple wood screws. It works, but it takes some practice to get good bends. In a hobby shop, I came across a much easier way to bend music wire a couple months after I wrote that first column: the K&S Engineering Mini Wire Bender. This little beauty allows you to make accurate bends in solid brass or steel wire up to 1/8" diameter.

It's a two-piece unit, a steel base with a pivot pin and a clamping screw, and a torque handle that fits over the pivot pin. First you securely clamp the base in the jaws of a bench vise, then place the wire to be bent diagonally between the pivot pin and the camping screw. Next, tighten the clamping screw to hold the wire in place, and fit the torque handle over the pivot pin. A short steel pin protrudes downward from the torque handle and engages the wire so that when you pull the handle back, the wire bends around the pivot pin. It produces a perfect radius and the wire doesn't even get nicked. Cost? Just $10.00 US.

You should be able to find one of these in any well-stocked hobby shop. If you can't find one, try contacting the company directly:

K&S Engineering
6917 West 59th Street
Chicago, IL 60638
Tel: 773-586-8503
Fax: 773-586-8556

Forgotten Technologies

Robot builders — or thing-makers of any kind, for that matter — are always on the lookout for information about new techniques and tools to build oddball devices. Sometimes just knowing that a certain tool exists can inspire solutions to problems that seem unsolvable at first.

Sometimes the tools and techniques don't even have to be new to be of help. In fact, sometimes the older and more obscure the stuff is, the more readily it can be adapted and used by the amateur. These "forgotten" technologies use old tools and methods that are often cheaper and more easily understood than modern processes.

I spend a lot of time browsing books, magazines, and websites looking for these little kernels of forgotten tech. This month, I came across a treasure trove: John Strong's 1938 *Procedures in Experimental Physics*. It was out of print until 1986 when Lindsay Publications reprinted it under their "Lost Technology" series (ISBN 0-917914-56-2). At $25.95 US, it's a bargain.

In Strong's book, you'll find detailed drawings and hands-on descriptions of doing laboratory glass-blowing, working with high vacuum, making optical instruments, Geiger tubes, photometers, electrometers, and many other devices, exotic and mundane. The book is old enough that many of these techniques aren't taught anymore, not because they aren't useful, but because they can't be as readily automated or are too expensive for mass production. But for one-off work, they can be ideal. Browse through this book and dream of what you could make.

Lindsay Publications specializes in books that encourage not only dreaming but doing. Just reading their catalog alone is inspirational. Check out their website at www.lindsaybks.com. Order their catalogs. You won't be disappointed.

Enough, Already!

That's all my space. Next time, I'll give Breadbot its fourth brain transplant, program the new brain, and add some spiffy wheel rotation sensors. **NV**

As always, if you have suggestions for improving Breadbot, if you've built a Breadbot, or if you have questions or comments about amateur robotics topics, you can reach me at:

Robert Nansel
69 S. Fremont Ave. #2
Pittsburgh, PA 15202
E-Mail: bnansel@nauticom.net

New Product News

Continued from page 4

EDE702 SERIAL LCD INTERFACE IC

E-Lab Digital Engineering, Inc. announces the release of their new EDE702 Serial LCD Interface IC.

This IC has been especially designed for cost-sensitive OEM applications, allowing nearly any text-based liquid crystal display screen to be controlled via a one-wire serial link – ideal for embedded microcontroller applications where minimal I/O pin usage is desired.

The EDE702 allows full LCD control, including the creation of custom characters, scrolling text, cursor on/off, etc.

With 2400/9600 baud rate and selectable data polarity, the EDE702 can interface to nearly any microcontroller capable of sending asynchronous serial data, and connection can be made without any type of voltage level conversion hardware.

The EDE702 allows circuit designers to easily add a LCD screen to their design without the increased software overhead or I/O requirements accompanying the usual 11-pin LCD interface.

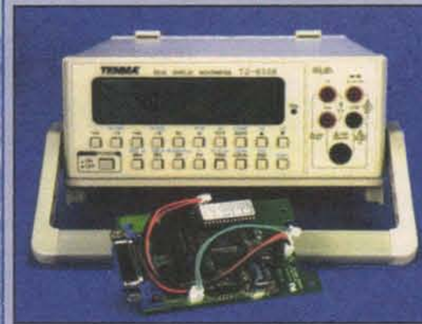
A serially-controlled digital output pin on the EDE702 makes its one-pin serially interface effectively a zero-pin interface! Eighteen pin DIP or SOIC packages are available; 1K pricing is $4.50

For more information, contact:

E-LAB DIGITAL ENGINEERING, INC.
1600 N. 291 HWY. STE. 339 DEPT. NV
INDEPENDENCE, MO 64056
816-257-9954 FAX: 816-257-9945
WEB: http://www.elabinc.com
E-MAIL: support@elabinc.com

NEW DUAL DISPLAY MULTIMETER

Tenma Test Equipment announces the introduction of their new Model 72-6558 Professional Dual Display True RMS Multimeter; available from MCM Electronics.



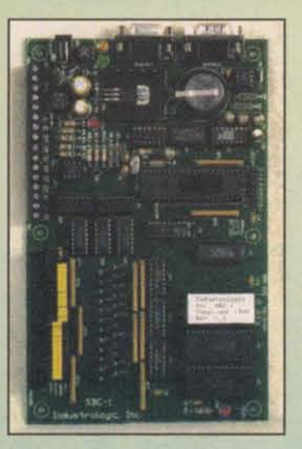
The multimeter's features are: Dual 5-1/2 digit back-lit LCD display with analog bargraph; simultaneous measurement of two different parameters of the same signal; selectable count resolution of 200,000, 20,000, and 2,000; measures AC and DC voltage and current, resistance, frequency, capacitance, and temperature; true RMS AC and AC+DC measurement; and 1000V maximum DC measurement with 1mV resolution and 0.01% accuracy.

The new model 72-6558 at only $579.00 also includes an RS-232 interface and can be used in IEEE systems with optional IEEE-488 GPIB interface.

For more information, contact:

MCM ELECTRONICS
650 CONGRESS PARK DR., DEPT. NV, CENTERVILLE, OH 45459
937-434-0031 FAX: 937-434-6959 1-800-543-4330
WEB: www.mcmelectronics.com

SBC-1 EMBEDDED CONTROLLER



Industrologic is now shipping its SBC-1 embedded controller. This 80C51 system presents a menu-driven operating system that includes complete diagnostic and system functions such as user program upload and download, and remains onboard and usable for the life of the product.

Size is 5" x 8", I/O signals total 50 (26 I/ 24 O).

A module rack (50-pin header) interface is included, as well as two RS232 connectors, eight-bit analog input, real-time clock, system support for assembled and compiled programs, and an enhanced TinyBASIC interpreter in ROM that has debug, load and save, and I/O commands. All features listed are standard.

A full developer kit with board, manual, supply, serial cable, and software diskette is $179.00.

For more information, contact:

INDUSTROLOGIC, INC.
3201 HIGHGATE LN., DEPT. NV, ST. CHARLES, MO 63301
314-707-8818 WEB: www.industrologic.com

BIRDWATCHER II

Glentech, Inc. introduces the BIRDWATCHER II, the first dial-in remote sensing interface for the Bird Model 43 wattmeter.

The BIRDWATCHER II and included software allows remote RF data access by simply plugging the wattmeter into a telephone line. BIRDWATCHER II software provides a big screen analog and digital remote sensing display from anywhere in the world.

The fully assembled and tested BIRDWATCHER II PC board mounts on the meter terminals of the wattmeter and has two modes of operation. In the bypassed mode, the wattmeter operates in its original configuration without degradation. In the enhanced operation mode, the wattmeter is interfaced with the telephone line allowing for full digital and analog computer screen display of wattmeter measurement and movement.

Supplied with a custom back panel for the Model 43, all modifications are completely reversible.

The BIRDWATCHER II with dial-in telephone interface is priced at $249.95 and BIRDWATCHER I (serial interface) is priced at $149.95. Both come fully assembled and tested.

For more information, contact:

GLENTECH, INC.
731 W. LUNT AVE., DEPT. NV, SCHAUMBERG, IL 60193
847-891-2584 FAX: 847-891-2587
WEB: http://www.glentech-rf.com

KENWOOD CS-5300 SERIES ANALOG OSCILLOSCOPES

Products Intl., Inc. introduces the new CS-5300 series of analog oscilloscopes from Kenwood. These oscilloscopes are available in either 50 MHz or 100 MHz, with or without cursors, and readouts.

The CS-5300 series does not use multi-function knobs. Thus, an inexperienced person may use it easily. Straightforward switch layout on the panel eliminates errors even on complicated operations.

The CS-5300 series also feature: Automatic setup of both horizontal and vertical axis (CS-5370/5350), with the models with readout function, waveforms can be displayed in optimum sizes by simply pressing the auto button once.

Automatic measurements of voltage and frequency (CS-5370/5350), even analog oscilloscopes, these models are capable of measuring the parameters of input signals automatically.

Plus/minus 2% accuracy with both horizontal and vertical axis, all of the four models achieve high measurement accuracy of 2%.

Multi-trace display of any desired channel.

Relay attenuator with improved reliability.

For more information, contact:

PRODUCTS INTL., INC.
8931 BROOKVILLE RD.
DEPT. NV
SILVER SPRING, MD 20910
301-587-7824 FAX: 301-585-5402
1-800-638-2020
E-MAIL: scott@prodintl.com

MODEL 12086 FILTER

The model 12086 eliminates harmonic interference at the C-band receive antenna with a low loss of 0.05 dB to the passband (3.7 to 4.2 GHz).

The filter installs between the feedhorn and low-noise amplifier to suppress the band of 5.925 to 6.425 GHz with a minimum rejection of 50 dB. The unit has a VSWR of 1.08:1. Grooved flanges are standard, but other connectors are available upon request.

For more information, contact:

MICROWAVE FILTER COMPANY, INC.
6743 KINNE ST., DEPT. NV
EAST SYRACUSE, NY 13057
315-438-4747 FAX: 315-463-1467 1-800-448-1666
E-MAIL: mfcsales@microwavefilter.com
WEB: http://www.microwavefilter.com

A LICENSE FOR MAKING MONEY

by Gordon West

How would you like to earn $1,000.00 a day by conducting a couple of ship radio station inspections aboard commercial boats required by law to carry marine radio equipment onboard? While this "make $1,000.00 a day as a licensed technician" sounds like a sales pitch for a training school, this deal is FOR REAL! The FCC has turned over ship radio inspections to a very limited number of marine electronics technicians who hold the required Global Marine Distress Safety System (GMDSS) maintainer's license, FCC test Element 9.

"Effective July 1, 1998, the Commission (FCC) will no longer be conducting ship (radio) inspections," reports J.R. Zoulek, District Director, Federal Communications Commission, Los Angeles, CA.

"The FCC inspects approximately 1,210 vessels each year. To be in compliance with the current rules that require that all inspections be conducted by the Commission, the FCC has had to hire part-time ship inspectors in remote areas ... to travel great distances to inspect radio stations on US ships. The new rules will relieve the FCC of these manpower and financial burdens, while permitting vessels the more convenient and cost-effective alternative of using FCC-licensed technicians from the private sector for inspections," comments the FCC in a recent news bulletin.

The typical FCC fee for inspecting the radio station of a US vessel transporting more than six passengers for hire was $320.00, and the average time onboard might be less than an hour. For ocean-going vessels, the fee was $620.00, and the inspection time might take all morning or it might take all afternoon. But if everything was in order, it might only take a couple of hours!

"And arranging for the old FCC ship radio station inspection required months of pre-planning, scheduling, and pre-payment to the Commission," comments Daniel Freniere, captain of CALIFORNIA RESPONDER, a giant oil spill emergency response vessel out of Port Hueneme, CA. "We think that ship radio inspection privatization will be good for everyone," adds Freniere who holds a marine radio operator's permit (Element 1), as well as the GMDSS radio operator license (Element 7).

FCC COMMERCIAL RADIO LICENSE ELEMENTS

In 1993, the FCC turned over commercial radio license examinations to the private sector. The commercial radio license testing would operate very much like the amateur and aeronautical testing systems after which it was patterned. The old radiotelephone first class, second class, and third class licenses had already been combined into the big general radio operator license 10 years earlier. The marine radio telegraph license was still on the books, but there weren't many applicants going for this outmoded means of communications. The ship radar endorsement was kept active, and the broadcast and aircraft endorsements were dropped.

The FCC ADDED the global marine distress and safety system operator's license for operation of the new satellite-based marine emergency sub-systems and equipment. This license will eventually replace all of the Morse Code operator certificates.

The FCC also added the global marine distress and safety system MAINTAINERS license necessary for the repair, INSPECTION, and maintenance of satellite-based marine emergency sub-systems and equipment.

BIG SHIP RADIO INSPECTIONS MAY TAKE SEVERAL HOURS AT $75.00 AN HOUR.

The natural progression for the study, testing, and starting employment in the marine and aviation market would be to first obtain the general radiotelephone operator license (GROL) with radar endorsement.

Element 1
Marine radio operator permit (MROP), 24-question, multiple-choice exam on rules & regulations

Element 3
General radiotelephone operator license (GROL), 76-question exam on basic radio electronics

Element 8
Ship radar endorsement, 50-question written examination on ship and aviation radar equipment

Successfully passing each of the three elements (Element 1, Element 3, and Element 8) leads the applicant to the important GROL license with radar endorsement. This allows the marine and aviation electronics technician to work on conventional radio and radar equipment found in airplanes and on boats. The GROL license with radar endorsement is usually a requirement for getting into land mobile radio repair, although the FCC no longer requires land mobile radio techs to hold a commercial license. But many employers will look for an applicant with GROL with radar, as opposed to an applicant who may have no FCC license.

But the GROL won't qualify the technician for the new type of satellite-based equipment going aboard pleasure yachts, small commercial boats, and small and large passenger ships who are not required by GMDSS laws to carry specific pieces of satellite or terrestrial emergency radio equipment onboard. All United States cargo and other commercial vessels, regardless of their area of operation, are required to be GMDSS compliant by February 1, 1999, if they are over 300 gross tons. Boats carrying more than 12 passengers for hire and operating on international voyages are also required to be GMDSS compliant by this date.

The Federal Communications Commission (FCC) commercial general radiotelephone operator license (GROL) lets you repair and adjust aeronautical and marine radio transmitters. The radar endorsement gives you legal access to fix the microwaves. But the granddaddy of them all — GMDSS maintainer — gets you into a brand new market of ship radio station inspections that the FCC has just privatized ...

Vessels carrying more than six passengers operating in local waters may not be required to be GMDSS compliant, BUT ARE SUBJECT TO OTHER RADIO AND LICENSING REQUIREMENTS and the operator must hold, as a minimum, a marine radio operator's permit, Element 1. Small commercial vessels and recreational vessels are not required to outfit for GMDSS, but may use this equipment on a voluntary basis without any operator licensing requirements. In other words, pleasure craft may not need this satellite-type equipment, but if there are any adjustments to the two-way radios onboard, they must be made by a licensed technician holding a GROL permit.

The designated GMDSS operator onboard one of the commercial vessels will be required to hold the GMDSS radio operator's license, test Elements 1 and 7. Element 7 is a question pool of 444 multiple-choice questions of which 76 will be on the test. Seventy-five (75) percent passing grade is required, and these test elements tend to be more about procedures with very little super-technical questions on amps, volts, or Ohm's Law. Element 1 is the maritime radio rules and regs. Both question pools can be studied and passed with about two or three weeks of reviewing the question pools.

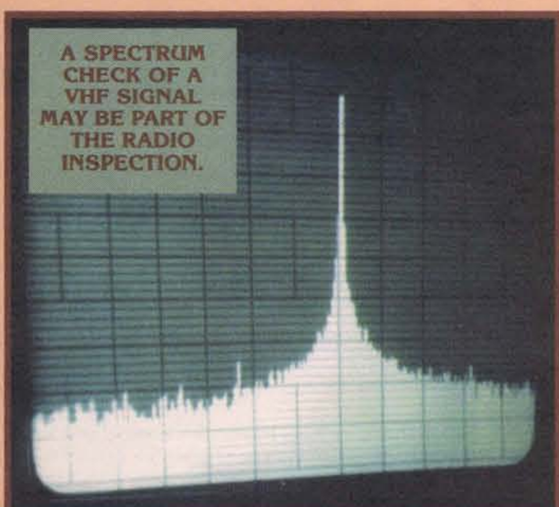
THE INSPECTOR'S LICENSE

To cash in on the new lucrative inspection business, you will need to hold written Element 1, rules and regs; written Element 3, the GROL technical element; and Element 9, the GMDSS radio maintainer element, based on a pool of ●

RADIO INSPECTORS WILL NEED TO BE FAMILIAR WITH GMDSS TERMINALS.

250 questions of which 50 technical questions will be on the test.

It is recommended that applicants first prepare and pass written Elements 1, 3, and radar endorsement, Element 8. These 3 elements can be found in the $34.95 soft-covered book, *GROL PLUS*, written by Gordon West and available for $30.00 from Gordon West Radio School, 2414 College Drive, Costa Mesa, CA 92626. (Please add $3.00 for Priority Mail, and I am happy to autograph the book for you!) It contains every question, the four multiple-choice answers, a description of the correct answer and how to solve technical questions mathematically, and is your one big source for getting through your marine radio operator's permit and general radio operator license with radar endorsement in one soft-cover copy.



A SPECTRUM CHECK OF A VHF SIGNAL MAY BE PART OF THE RADIO INSPECTION.

Testing is offered by private commercial operator license examination managers throughout the country, and there are phone numbers to call to locate an examiner or examination team near you. And you can even call ME if you have technical questions about problem-solving within the book!

But you will need to study and pass the more technical GMDSS MAINTAINER 50-question test. If you would like a complete booklet on all of the GMDSS operator and maintainer test questions, along with the correct answer, send an additional $10.00 and I'll include them with my GROL book!

The FCC reports there are over 4,000 GMDSS licensed operators who have passed the test as of August of this year, but only 850 GMDSS maintainer licenses that could allow the license holder to become a ship radio station inspector.

"The Global Maritime Distress and Safety System (GMDSS) replaces the ship-to-ship safety system that used manual Morse Code with a ship-to-shore safety system that used satellite and automated terrestrial communications systems," comments George Dillon with the FCC in Washington, DC. "The FCC requires specific classes of licenses for the inspection of certain categories of ship radio stations. Inspection of cargo vessels or passenger vessels equipped with GMDSS equipment must be conducted by an FCC-licensed technician holding a GMDSS radio maintainer's license," adds Dillon (Internet address: gdillon@fcc.gov).

The vessel owners and operators most likely have a clear picture on whether or not they require periodic ship radio station inspection. In the past they have been inspected by the FCC, but now they are told the FCC no longer conducts these inspections and they must go to the private sector. And here is where you come in.

If you hold the GMDSS radio maintainer's license, along with the very necessary MROP, GROL, and radar endorsement, not only can you give inspections, but you could also do technical repairs and adjustments on the spot to bring the vessel up to full compliance. Plus getting the word out that you are the local fixer and inspector is going to be tough unless you are already signed up with a local marine electronics dealer who regularly goes aboard commercial boats to adjust the radio apparatus.

"You might look in the yellow pages under marine radio inspectors," comments the FCC out of a local Southern California office. "Or maybe post notices where they might be read by big ship operators," adds the FCC. I recommend visiting your local marine electronics dealer, and working out a plan where you could offer an inspection if they don't already have a GMDSS radio maintainer on staff.

You should also begin working with the national GMDSS implementation task force.

Jack Fuechsel, Executive Director
7425 Elgar Street
Springfield, VA 22151

"The national GMDSS implementation task force was chartered by the US Coast Guard to supplement government functions in expediting the implementation of the global maritime distress and safety system now being introduced by the International Maritime Organization (IMO)," comments Captain Fuechsel, Executive Director. "We have written to the Coast Guard Auxiliary and to the US Power Squadrons asking them to incorporate GMDSS and especially VHF-DSC (digital selective calling) in their public education courses. Your readers can find most GMDSS task force information bulletins and other documents on the Coast Guard's Internet web site at http://www.navcen.uscg.mil /narcomms.htm," adds Fuechsel.

As more big ship and medium-sized yacht communications go from microphone to keyboard, there will be a greater need for qualified marine electronic technicians with a strong background in satellite and digital communications.

Becoming a ship radio station inspector could earn good financial rewards once the word gets out that you are a competent inspector with the capabilities of offering repairs or board replacements right on the spot. But I would strongly suggest you work closely with a big marine electronics provider so the compulsory-equipped big boat operators will know who to contact for inspections and maintenance. Get started with the GROL Elements 1, 3, and radar endorsement 8. Take these tests in one sitting, and then tackle Elements 7 and 9. Having these licenses could lead to an exciting career in marine electronics and commercial ship radio station inspections. NV

CATEGORY OF VESSEL	*MINIMUM CLASS OF FCC LICENSE REQUIRED BY PRIVATE SECTOR TECHNICIAN TO CONDUCT INSPECTION — ONLY ONE LICENSE REQUIRED*			
	General Radiotelephone Operator License	GMDSS Radio Maintainer's License	Second Class Radiotelegraph Operator's Certificate	First Class Radiotelegraph Operator's Certificate
Radiotelephone equipped vessels subject to 47 CFR subpart R or S	✔	✔	✔	✔
Radiotelegraph equipped vessels subject to 47 CFR subpart Q			✔	✔
GMDSS equipped vessels subject to 47 CFR subpart W or subpart Q		✔		

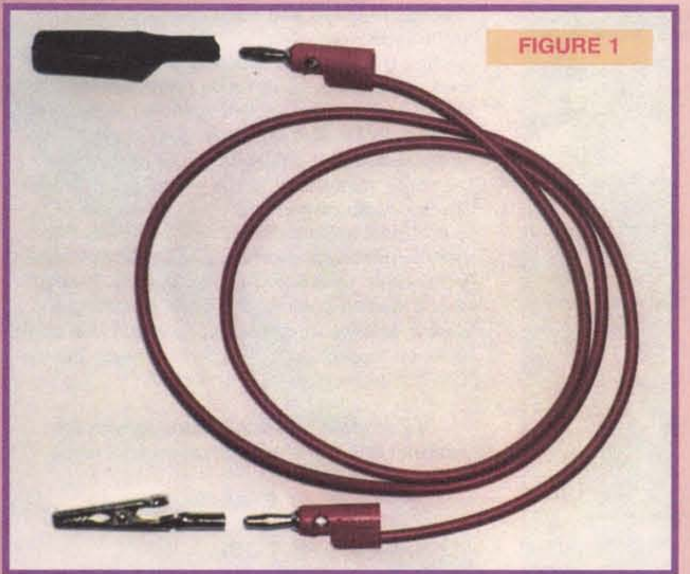


FIGURE 1

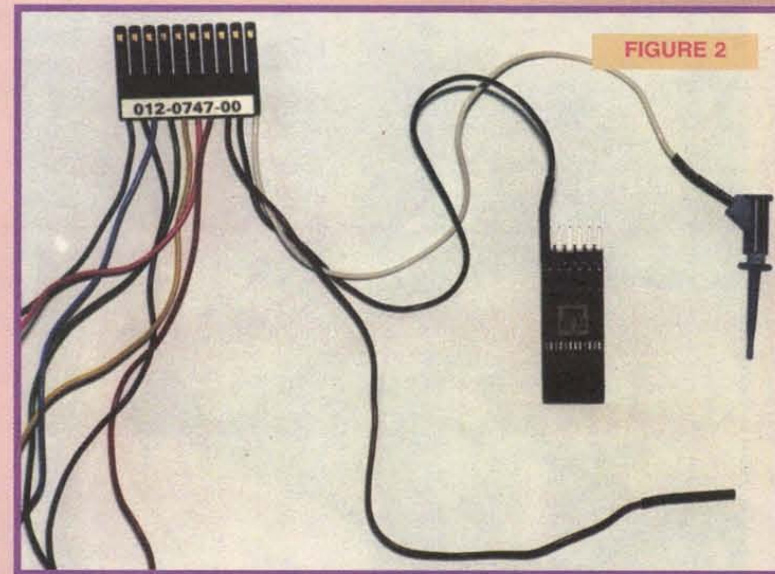


FIGURE 2

Test Leads

by Gerald Roylance

INTRODUCTION

It's pretty hard to get excited about a bunch of low-tech wires, but they are necessary. Using the wrong cables creates clumsy connections that take a long time to make, fall apart when you breathe on them, and compromise measurements. Good leads make solid electrical and mechanical connections. A well-equipped lab needs a wide selection of test leads to connect power supplies, signal generators, and oscilloscopes to circuits being tested.

Test leads can be split into two broad categories: single leads (e.g., clip leads) and shielded cables (e.g., coaxial cables). For each category, I will describe what is useful and suggest products. Part numbers and approximate prices are included.

SINGLE LEADS

Ordinary leads are separate wires that are used to connect power supplies, make DVM measurements, or clip in debugging components such as potentiometers or capacitors. Heavy gauge wire is needed for power supplies and high current measurements, and delicate clips are needed for small components.

Banana Plugs and Alligator Clips

In the old days, test leads were almost always some combination of pin plugs, banana plugs, and alligator clips. Pin plugs have pretty much disappeared, and instead of having all combinations of banana plugs and alligator clips, it makes more sense to have a collection of banana plug leads and separate alligator clips that slip onto the banana plugs (see Figure 1).

For many years, ITT Pomona has made stackable banana plug leads (Pomona calls them patch cords) that are ideal for this purpose. These patch cords use 18-gauge wire, so they are good power supply leads. Some alligator clips and insulating boots turn the patch cords into alligator clip leads.

The middle number in Table 1 is the length in inches, and the last number is the color code (Pomona uses the resistor color code). I have a wide selection of patch cords in several lengths and colors. Short lengths are not used often, but they are good for connecting chassis grounds to isolated supply terminals, for example. To get from an instrument to a prototype needs 24-inch leads if they are on the same surface (e.g., the bench top). Longer leads (36 to 48 inches) are needed to go from a shelf above the table to the bench or from an instrument cart to the table. If the leads are too long, then they tangle and get in the way.

Hooks and Grabbers

Components are smaller these days, so banana plugs and alligator clips are too large for signal connections. Hooks (also called grabbers) are now more common than alligator clips, and they come in many sizes. Pomona's tradenames are Minigrabber, Micrograbber, and SMD Grabber, and single leads cost from $4.00 to $6.00 each.

When I needed several small clip leads, I bought a set of five small, 16-inch hooks (Philmore No. 500, IC Test Leads). The set was cheap (only $10.00), but it has given me lots of trouble. The leads use solid instead of stranded wire, so the leads are stiff and less reliable. One lead became intermittent when I was tuning some 7th order elliptic filters for a client; that failure cost much more than the whole set. I do not recommend the Philmore leads, but I continue to use it — warily.

Someday soon I will replace the Philmore set with some leads that have sockets for 0.025-inch posts. Most logic analyzer leads use these sockets because they mate with ribbon cable headers and the posts on IC test clips (see Figure 2). It's silly to have hooks flopping off an IC test clip. Furthermore, you can get grabbers with 0.025-inch posts to put on the end of these leads — just like putting alligator clips on the end of banana plugs.

SHIELDED CABLES AND ADAPTERS

Some labs have huge collections of test leads to cover the wide variety of possible connections: BNC to banana plugs, BNC to hooks, BNC to alligator clips. The enormous variety is due to the profusion of different connectors. If we limit the domain to just RF connectors, then there are the common BNC, TNC, N, F, and SMA families. Add to that list the more exotic RF connectors, such as SMB, SMC, and the ultra-serious APC-7. Older RF equipment needs UHF, GR, and BSM connectors. Having test leads for all possibilities requires a lot of space and is expensive.

The saner approach is to own a selection of standard cables of different lengths and use adapters. My standard cables are BNC male on each end and range from 12 to 60 inches long. BNC cables are an obvious choice because most

Patch cord, 24in, black	Pomona B-24-0	$3.70
Patch cord, 24in, red	Pomona B-24-2	$3.70
Alligator Clips (10 pack)	Pomona 2240	$6.00

TABLE 1

0.025 inch patch cords	Pomona 4741-6-*	$3.55
Kit of 10	Pomona 5948	$20.90
Micrograbber with 0.025 post	Pomona 4521-*	$2.50
Kit of 10	Pomona 5925	$22.50

TABLE 2

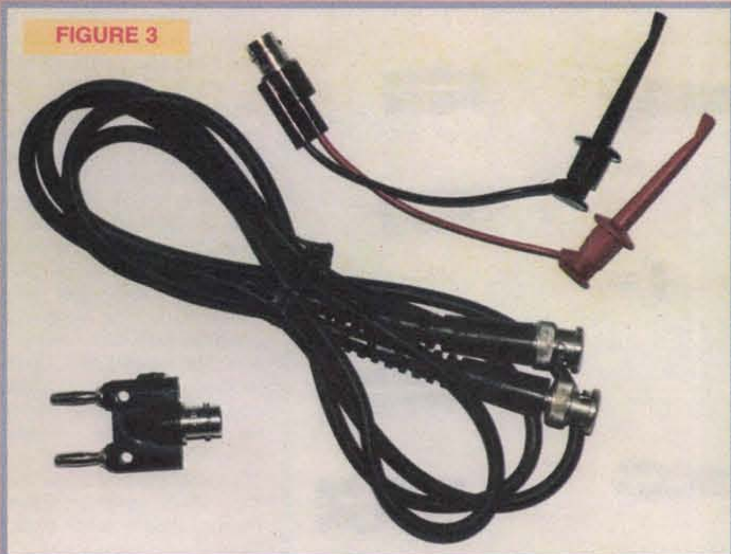


FIGURE 3

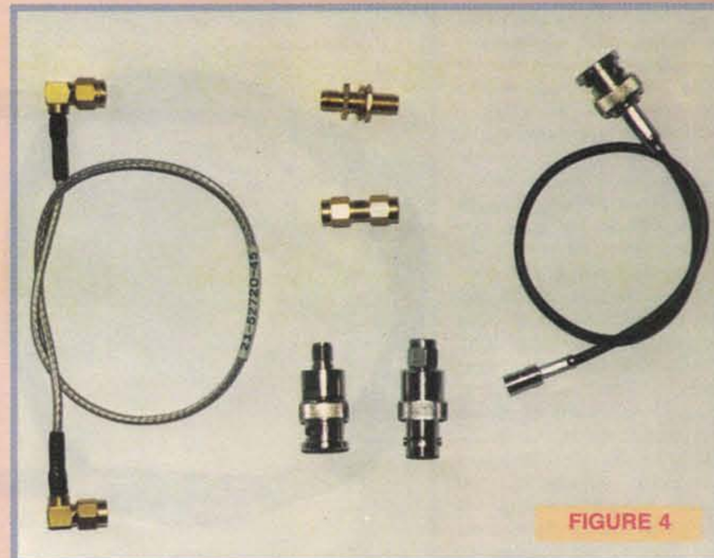


FIGURE 4

of my test equipment uses BNC connectors. BNC connectors are rugged, mate quickly, and have reasonable RF performance. In contrast, F connectors are fragile, take a long time to screw on, and destroy your fingers. Most of my cables are 50-ohm RG-58, but some are RG-174 (thin) or RG-59 (75-ohm).

Standard cables and an array of adapters save money and clutter. An adapter usually costs less than a cable, takes less space, and won't tangle. With a small set of adapters, you can cobble together a cable with unusual connectors, such as an F connector to RCA phonograph plug — something I actually had to do when I connected a folded dipole antenna to a cheap receiver.

BNC Cables

Reliability is important, so all my BNC cables have crimp connectors. Clamp connectors are less rugged and more likely to be improperly assembled. At one place I worked, intermittent clamp connectors caused so much grief that any suspicion demanded instant amputation. I would stay away from twist-on connectors for lab work, but I have used twist-on F connectors for TV installations.

Buying BNC Cables

Good BNC cables are not expensive. I bought most of my BNC cables at surplus stores. The price is about $5.00 for a used cable, but I have paid as little as $2.00. The main features of surplus cables are quality connectors and professional construction. New cables from ITT Pomona Electronics sell for about $12.00 per cable; the last two digits in Table 3 specify the length in inches.

BNC Cable, 12inch	Pomona 2249-C-12	$11.75
BNC Cable, 24inch	Pomona 2249-C-24	$11.75
BNC Cable, 36inch	Pomona 2249-C-36	$11.75
BNC Cable, 48inch	Pomona 2249-C-48	$14.65
BNC Cable, 60inch	Pomona 2249-C-60	$14.65

TABLE 3

Making BNC Cables

You can make your own cables, but consider the total cost and the reliability. You must make several cables to cover the tooling cost. If your assembly skills are poor, then you will end up distrusting the cables and amputating suspect connectors.

A crimp tool with the appropriate die for the coax and connector is a necessity. The better crimp tools have ratchets to guarantee a complete crimp cycle (the military demands ratchets). An Ideal Crimpmaster with one die costs about $55.00. The Crimpmaster uses interchangeable dies, so it can cover several different cables and connectors. You can buy no-name crimp tools for about $25.00, but finding additional dies is difficult.

The dies will have at least two cavities. The large cavity is for crimping the braid, and the coax cable determines its size. The smaller cavity is for the center pin, and the connector type determines its size. Crimp tools that don't have a cavity to crimp the center-pin are useless. Crimping the center pin with a pair of pliers is not an option.

IDEAL CRIMPMASTER

Frame+Die	Die Only	Cable	Connector Family	Cavity Sizes
30-483	30-578	RG6, RG59	BNC and TNC	.324, .255, .068, .042
30-484	30-587	RG58, RG174	BNC and TNC	.213, .178, .068, .042
30-502	30-581	RG58, RG59/62	BNC and TNC	
30-503	30-582	RG6, RG59	F	
30-482	30-577	RG8/11	N	

TABLE 4

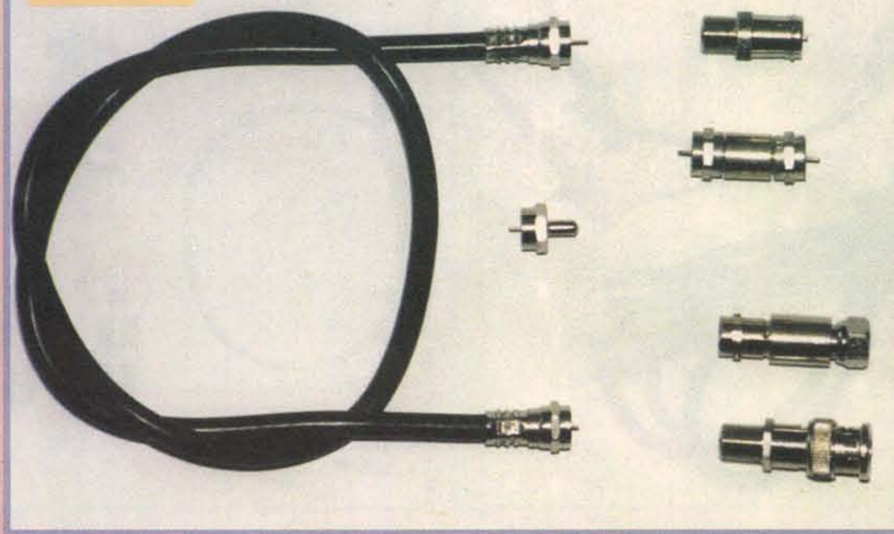
Ideal Crimp Tools

A cable-stripping tool may be handy, but I have had poor luck with them. I have tried a half dozen different models, but only found one that worked well, and it was for RG8. The others required delicate adjustments, and I spent more time adjusting the stripper than using it. By the way, before stripping a cable, lightly roll the end on the floor with

Feed-through terminator	Pomona 4119-50	$45.00
Terminator	Halted #971LB	$1.49

TABLE 5

FIGURE 5



your foot. Rolling the cable makes the end round again — cutting or bending a cable often flattens it and makes the stripper nick the wires.

I strip coax cables with a pocketknife. To avoid nicking the braid or the wire, I don't cut all the way through the insulation, but leave a little that I can pull or twist off.

In addition to the tooling, you need the cable and the connectors. RG-58 coax costs about $0.15 per foot. Cheap BNC connectors cost about $1.50, and higher quality connectors range up to $10.00 each. Common brand names for connectors are Amp, Amphenol, and Kings. Make sure you get all the parts — some distributors sell from bulk packaging, and the stock clerks may miss some important pieces for RG174 connectors. Also get the assembly instructions, because the strip lengths are important in making a reliable connector.

Buying a quality used cable for $5.00 is a better deal than making a new one for $3.50 (plus the cost of tooling), but I do make some of my cables. The market in new and used RG174 cables is very small, so making them from scratch is more attractive. New RG174 cables from Pomona cost $18.00, so making just a few cables will pay for the crimp tool.

Cable-to-Cable Connectors

If you want to connect two cables together, you need a barrel connector (BNC(f) at both ends). A BNC T connector — female at both ends with a male connector sticking out the side — also works. It compromises the impedance match and the shielding, but the T is useful for high-impedance scope and meter connections.

BNC(f) to N(m)	Mouser 161-9736	$4.17
BNC(f) to TNC(m)	Mouser 161-9734	$2.18
BNC(f) to Mini-UHF(m)	Halted #590B	$2.95
BNC(f) to UHF(m)	Halted #950NPB	$1.95

TABLE 6

BNC(f) to dual banana plug	Pomona 1269	$5.80
BNC(m) to dual binding post	Pomona 1296	$10.75

TABLE 7

BNC(f) to Minigrabber clips	Pomona 3788	$8.20
BNC(f) to Micrograbber	Pomona 5188	$10.85
BNC(f) to 0.025 sockets	Pomona 5069	$8.35

TABLE 8

BNC Terminators

You should have some 50-ohm BNC terminators. Many scope inputs are high input impedance, and connecting cables to these inputs causes reflections. A terminator at the input will kill these reflections. Feed-through terminators are best because they minimize stub length, but a 50-ohm terminator attached to a BNC T also works. In desperate times, I've plugged 51-ohm resistors into BNC Ts.

Adapters

Adapters allow you to change a BNC cable into almost any other kind of cable. Adapter quality and price vary widely. Mil-Spec connectors have good finishes and mate smoothly. Unfortunately, they cost $10.00 to $50.00 each. At swap meets and surplus stores, you might find them for about $5.00. Lower quality adapters cost much less and will serve most users.

Going from BNC to some other connector system could require any of four adapters: two connector and two possible sexes create a total of four combinations. We could require a lot of adapters. Fortunately, most coaxial connections follow a convention: the cables use male connectors and the instruments use female connectors. If all parties follow the cable convention and all cables use BNC connectors, then we need only one combination: BNC(f) to Other(m).

We can cover many conversions with a shopping list that adapts BNC(f) to Other(m). Other adapters need more explanation, and are covered later. I usually get at least two of each adapter that I need. I don't have any TNC or mini-UHF adapters because none of my equipment uses those connectors.

BNC to Dual Banana Plug

Some of my instruments have dual banana jack inputs. Initially, I attached dual banana plugs to shielded cables, but those cables had several problems. They weren't very rugged, and mechanically attaching the cable to the plug was never pretty — knots and cable ties lack aesthetic appeal.

Then I discovered a Pomona 1269 BNC(f) to dual banana plug adapter, and threw away my dual banana plug cables (see Figure 3). The adapter is very rugged, and I use them a lot. A Pomona 1296 is useful for going the other way, but you will use it less often.

BNC to Clip Leads

I've seen many ersatz 1X "scope probes" made from coax cable. There's a BNC(m) on one end, and the other end sports soldered-on alligator clips or grabbers. These probes look ugly and are not sturdy. The coax braid is exposed and can short nodes to ground, and the fine wires in the braid fray quickly. The center lead of a coax cable is fragile, so its attachment to the alligator clip breaks easily. The center dielectric is stiff, so the center cable connection is not very pliable.

A better solution — one that avoids the above faults — uses a clip lead adapter at the end of an ordinary BNC cable (Figure 3). I have two Pomona 3788 adapters (BNC(f) to six-inch Minigrabber leads), and I use them all the time. I'll use one to supply the output of my function generator to the prototype, and the second to connect my digital voltmeter (DVM).

In fact, I almost always use my DVM with the combination of the Pomona 1269, BNC cable, and Pomona 3788; the only problem is the exposed (uninsulated) BNC connectors. The Minigrabber is easier than using a point probe, and the coax cable avoids tangled probe leads. Pomona also has a Micrograbber version, but the 5069 and separate Micrograbbers is a better plan.

BNC to SMA and Friends

For low frequencies, BNC to SMA adapters work okay (see Figure 4), but the conversion from the delicate SMA connector to the larger BNC is mechanically awkward. I often worry that I'm going to break an SMA connector with the lever arm made by the adapter and the BNC cable connector.

For microwave signals, avoid adapters and BNC hardware. Instead, use good cables with SMA connectors. Unfortunately, SMA cables cost a small fortune — $40.00 to $50.00 each — and the performance requirements are high enough that you don't want to make them yourself. SMA cables use silver-plated conductors, teflon dielectric, and gold-plated connectors. Instead of buying SMA cables, I bought some microwave hulks and salvaged some cables (and a lot of other stuff in the bargain).

With your SMA cables, you will want some barrel connectors and some BNC(m) to SMA(f) adapters. Although BNC Ts are common, never buy an SMA T.

Some instruments use SMB or SMC connectors, and for these delicate connectors I've thrown in the towel and opted for special-purpose cables (scrounged from microwave hulks or bought from surplus dealers). I have some SMB(m) to BNC(m) cables for my counter, and some SMC(m) to SMA(m) cables for my microwave detectors.

Although there have been several good deals on microwave equipment with hermaphroditic APC-7 connectors, I've shied away because the adapters are too expensive. Used APC-7 to SMA adapters cost about $70.00.

N Connectors

N connectors are high-performance RF connectors that are used in the Gigahertz range. They offer better impedance control than BNC connectors, handle more power, and are often weatherproof. They are found on signal generators and network analyzers.

By the way, the term N connector is short for Navy connector, and the term BNC is short for Bayonet Navy Connector. The connectors are related in more than just name: an N(m) actually mates with a BNC(f). The other combination (which is the one we want) doesn't mate, so you will need some N(m) to BNC(f) adapters.

If your interest is microwave, then you want N(m) to SMA(f) adapters. BNC does not have the performance.

Almost all N connectors are 50-ohm, but 75-ohm N connectors also exist. Unfortunately, they don't look much different, and inadvertently mating them can wreck one of the connectors. There

BNC(f) to SMA(m)	Halted #11335B	$3.89
BNC(m) to SMA(f)	Halted #11340B	$3.89

TABLE 9

F(f) to push-on F(m)	Halted #FC62B	0.69
F(f) to F(f) barrel	Halted #FC67B	0.39
F(m) to F(m)	Halted #FC73B	0.89

TABLE 10

BNC(f) to F(m)	Mouser 161-9731	$2.23
BNC(m) to F(f)	Mouser 161-9733	$2.21

TABLE 11

BNC(f) to RCA(m)	Halted #957B	$1.49
BNC(m) to RCA(f)	Halted #955B	$1.29

TABLE 12

are even precision 75-ohm BNC connectors that should not be mated with 50-ohm BNC connectors.

BNC to F Connectors

The overwhelming feature of F connectors is that they are incredibly cheap. The center pin of an F connector is the solid center conductor of the coax cable, and it is easily bent. You must mate the connectors carefully. Their low cost is offset by the time to mate the connectors and the wear and tear on your fingers. If you do any bench testing with F connectors, get some push-on F adapters. These adapters have threaded F(f) on one end and push-on F(m) on the other. They save time and fingers.

Joining two F-connector cables requires a barrel connector. In some tests, I connect power splitters and directional couplers back-to-back, so F(m) to F(m) adapters are also useful.

F connectors are used in TV systems and imply 75-ohm cable. You will need a collection of 75-ohm (RG59 or RG6) cables. Although all your 75-ohm cables could use F(m) connectors, you will want some BNC 75-ohm cables because BNC connectors are more rugged. TV and cable test equipment use F connectors, but I have yet to see a scope with an F connector. Consequently, you will need two kinds of BNC-F adapters.

The BNC to F adapters don't address the impedance change between 50 and 75 ohms, and sometimes that change is critical. My signal generators, detectors, and oscilloscopes are 50-ohm instruments, so I have a couple of min-loss attenuators to adapt the impedance levels. Sorry, but I don't know an inexpensive source for these parts. When I visit a surplus store, I check the "vegetable drawer" of the Tektronix scope carts for this sort of gold. The store usually gives me a good price for this merchandise they didn't know they had. Twice I have considered buying a scope cart just for the contents of the drawer: once for the connectors and once for the scope manuals.

Audio

There is also tremendous variety in audio connectors, and a trip to the local audio store or RadioShack will let you load up on adapters among audio connectors using phone, miniature phone, subminiature phone, and RCA phonograph varieties. There are also mono and stereo variations of some connectors. Serious users will want some XLR connectors. Pay particular attention to the types of cables: there are speaker cables and microphone cables. The latter cables are shielded for low-level signals.

It doesn't make sense to use BNC cables as the standard in audio work. Instead I use subminiature stereo phone cables as the standard cable. Occasionally, you will want to connect an audio signal to your scope, and about the only common adapter is a BNC to RCA phonograph. I have both directions for this adapter, and have been surprised how often I use them. Many cheap radio and TV tuners use RCA jacks for RF connectors.

Most audio connections are 600 ohm, but the cable impedance is not 600 ohm. Reflections and impedance matching are not usually a problem at audio frequencies because the shortest wavelength is about 15 kilometers. **NV**

RESOURCES

HALTED SPECIALTIES, www.halted.com
1-800-4-HALTED, 408-732-1573

IDEAL INDUSTRIES, INC.
www.idealindustries.com
1-800-435-0705

ITT POMONA ELECTRONICS
www.ittpomona.com
909 469-2900

MOUSER ELECTRONICS, 1-800-346-6873

Write in 219 on Reader Service Card.

COPY HARD DRIVES INSTANTLY!

"THE FASTEST WAY WE'VE FOUND TO MASS PRODUCE SYSTEMS." ANDY HSU, GENESIS TECHNOLOGY

BUY MANUFACTURER DIRECT: $895

408 330-5543

FOUR DRIVE DUPLICATOR

Copy entire hard drives with ease. Drive duplicators are an essential tool for dealers and system builders. Why spend hours installing and formatting drives when you can clone four at once? This high speed, stand-alone IDE copier is easy to use and totally self-contained.

Set up any IDE or Ultra-DMA drive with all your original software. Connect blank drives and press "copy". You'll completely duplicate four drives faster and more accurately than you can copy just one on a PC!

Notebook and desktop drives are supported. Five separate ports let you copy drives at full speed without changing jumpers. Other copiers slow down with two or more drives attached. This true parallel transfer duplicator runs at full speed regardless of the number of drives attached. The built-in surface verification scans drives for perfect data integrity.

Call now and get the duplicator chosen and approved by Computer Sciences, IBM, and Maxtor.

CORPORATE SYSTEMS CENTER

3310 WOODWARD AVE., SANTA CLARA, CA 95054

WWW.CORPSYS.COM

This product is sold and intended for legitimate in-house duplication purposes only. Copyright laws must be observed.

Write in 213 on Reader Service Card.

Write in 194 on Reader Service Card.

NUTS & VOLTS MAGAZINE
430 PRINCELAND COURT
CORONA, CA 91719

CHANGE SERVICE REQUESTED

BULK RATE
U.S. POSTAGE
PAID
PERMIT No. 359
LONG BEACH CA